外部委託業者の募集

References: IO/23/OT/10028089/ERA

“Absolute Valve Feasibility Study"

（絶対バルブのフィージビリティスタディ）

IO 締め切り 2024 年 3 月 15 日(金)

〇はじめに

本事前情報通知（PIN）は、作業契約の入札授与および実行につながる公開入札調達プロセスの最初のステップです。

本文書の目的は作業範囲と入札プロセスに関する技術的な内容の基本的な要約を提供することです。

〇背景

ITER は平和利用の核融合発電の科学的および技術的な実現可能性の実証を目的とした、国際共同研究開発プロジェクトです。ITER 機構の 7 つのメンバーは、;欧州連合（EURATOM が代表）、日本、中華人民共和国、インド、大韓民国、ロシア連邦、および米国です。

ITER の敷地はフランス南東部のブーシュデュローヌ地区にあり、ITER 本社（HQ）もあるフランス CEA サン・ポール・レ・デュランス に近いところに位置しています。詳細については、ITER のウェブサイト http://www.iter.org を参照して下さい。

〇作業範囲

今回の入札プロセスでは、ITER真空容器（VV）とビームライン容器（BLV）の分離を提供する絶対バルブ(AV）と呼ばれる中性粒子ビームフロントエンド機器のフィージビリティスタディのための1つまたは2つのサービス契約を設定することを目指しています。

この構成部品は、NBシステムのこのセクションの一次真空格納容器を提供するものとし、したがって、容器内放射性インベントリの第1閉じ込めバリアの一部を提供します。

作業範囲(設計、解析、CAD)では、概念設計の成熟度レベルでの完全なAV設計の内容を定義します。

加熱用中性粒子ビームインジェクタ#1 (HNB 1）およびHNB 2専用のAVに限定されます。

AVは、IOによって概念成熟度レベルで開発されたトロリー支持体に搭載されています。このトロリーとのインターフェースは、契約者が開発するものとする。AVトロリーの変更（適合）および改良は、IOの審査および承認の下で認められます。

フィージビリティスタディの終了時に、概念機械設計を完了するものとします。ITER要件とNBセル環境を考慮してAVを構成するすべてのシステムの主要戦略を検証するために、NB概念設計レビュー会議が組織されます。

契約者は、技術仕様に定義されているすべての要件に適合する技術提案を提示し、明確に特定するものとします。

契約者はまた、何かあった場合には、バルブの開発の潜在的なリスクまたは致命的問題を提示できるものとします。

IO委員会は、技術的証拠に基づいてのみ、この種の声明の関連性を判断する必要があります。
このマイルストーンの結論として、次のステップである予備設計レビュー（PDR）に進むかどうかの承認を判断するものとします。
作業は敷地外で行うものとします。
フィージビリティスタディを成功裏に完了した事業体の間で、最大3個の絶対バルブの設計最終決定、製造およびテストのための新たな調達が続くことに留意が必要です。

〇調達プロセスと目的

目的は、競争入札プロセスを通じて供給契約を落札することです。
この入札のために選択された調達手続きは<u>公開入札</u>手続きと呼ばれます。
オープン入札手順は、次の 4 つの主要なステップで構成されています。

- ステップ 1-事前情報通知（PIN）

  事前情報通知は公開入札プロセスの第一段階です。IO は、関心のある候補企業に対し、以下の概略日程に示された期日までに担当調達担当官に添付の関心表明フォームで以下の情報を提出し、競争プロセスへの関心を示すよう正式に要請します。

  - 会社名
  - 登録の国名
  - 担当者名、email アドレス、肩書および電話番号

  <u>特に注意:</u>
  <u>関心のある候補企業は、IO Ariba の電子調達ツール 「IPROC」 に登録してください（まだ登録していない場合）。手順については、</u>
  <u>https://www.iter.org/fr/proc/overview</u>
  <u>を参照してください。</u>

  <u>Ariba (IPROC) に登録する際には、お取引先様に最低 1 名の担当者の登録をお願いします。この連絡担当者は、提案依頼書の発行通知を受け取り、必要と思われる場合は入札書類を同僚に転送することができます。</u>

- <u>ステップ 2-入札への招待</u>

  PIN の発行から 10 作業日経過後、提案依頼書（RFP）を 「IPROC」 に掲載します。この段階では、担当の調達担当者に関心を示し、かつ IPROC に登録している関心のある候補企業は、RFP が公表された旨の通知を受けることができます。その後、RFP に詳述されている入札説明書に従って提案書を作成し、提出します。

  <u>このツールに登録されている企業のみが入札に招待されます。</u>

- <u>ステップ 3-入札評価プロセス</u>

入札者の提案は、IO の公平な評価委員会によって評価されます。入札者は、技術的範囲に沿って、かつ、RFP に記載された特定の基準に従って作業を実施するために、技術的遵守を証明する詳細を提供しなければなりません。

- ステップ 4-落札

  認定は、公開されている RFP に記載されている、コストに見合った最適な価格または技術的に準拠した最低価格に基づいて行われます。

〇概略日程

概略日程は以下の通りです：

マイルストーン	暫定日程
事前指示書（PIN）の発行	2024 年 2 月 23 日
関心表明フォームの提出	2024 年 3 月 15 日
iPROC での入札への招待（ITT）の発行	2024 年 3 月 31 日
明確化のための質問（もしあれば）の回答締め切り	2024 年 4 月 29 日
入札提出	2024 年 5 月 13 日
契約評価と授与	2024 年 6 月 28 日
契約調印	2024 年 7 月

〇契約期間と実行

ITER機構は2024年の6月ごろサービス契約を授与する予定です。予想される契約期間は10か月の予定です。

〇経験

入札者は、付属書 I に詳細に示されている様に、その知識と関連産業分野における経験と能力があることを示す必要があります。

ITER での使用言語は英語で、流暢でプロレベルが必要です（口頭、書面とも)。

〇候補

参加は、個人またはグループ/コンソーシアムに参加するすべての法人に開放されます。法人とは、法的権利及び義務を有し、ITER 加盟国内に設立された個人、企業又は機構をいいます。ITER 加盟国は欧州連合(EURATOM メンバー)、日本、中華人民共和国、インド共和国、大韓民国、ロシア連邦、アメリカ合衆国です。

法人は、単独で、またはコンソーシアムパートナーとして、同じ契約の複数の申請または入札に参加することはできません。共同事業体は、恒久的な、法的に確立されたグループ又は特定の入札手続のために非公式に構成されたグループとすることができます。

コンソーシアムのすべての構成員(すなわち、リーダーと他のすべてのメンバー)は、ITER 機構に対し

て連帯して責任を負います。

コンソーシアムとして許可されるために、その点で含まれる法人はコンソーシアムの各メンバーをまとめる権限をもつリーダーをもたなければなりません。このリーダーはコンソーシアムの各目メンバーのために責任を負わなければなりません。

指名されたコンソーシアムのリーダーは、入札段階で、コンソーシアムのメンバーの構成を説明する予定です。その後、候補者の構成は、いかなる変更も ITER 機構に通知することなく変更してはなりません。かかる認可の証拠は、すべてのコンソーシアムメンバーの法的に授権された署名者が署名した委任状の形式で、しかるべき時期に IO に提出しなければなりません。

どのコンソーシアムメンバーも IPROC に登録する必要があります。

既に技術仕様書 ref 番号 ITER_D_9GUSMN に記載の絶対バルブに関するフィージビリティを実施している全ての法人は本オープン入札プロセスに参加する資格はございません。

【※　詳しくは添付の英語版技術仕様書「**Absolute Valve Feasibility Study**」をご参照ください。】
ITER 公式ウェブ　http://www.iter.org/org/team/adm/proc/overview からもアクセスが可能です。

「核融合エネルギー研究開発部門」の HP：　http://www.fusion.qst.go.jp/ITER/index.html
では ITER 機構からの各募集（IO 職員募集、IO 外部委託、IO エキスパート募集）を逐次更新しています。ぜひご確認ください。

イーター国際核融合エネルギー機構からの外部委託に関心ある企業及び研究機関の募集について

＜ITER 機構から参加極へのレター＞

以下に、外部委託の概要と要求事項が示されています。参加極には、提案された業務に要求される能力を有し、入札すべきと考える企業及び研究機関の連絡先の情報を ITER 機構へ伝えることが求められています。このため、本研究・業務に関心を持たれる企業及び研究機関におかれましては、応募書類の提出要領にしたがって連絡先情報をご提出下さい。

PRIOR INDICATIVE NOTICE (PIN)

OPEN TENDER SUMMARY

IO/24/OT/10028089/ERA

For

Absolute Valve Feasibility Study

Abstract

The purpose of this summary is to provide prior notification of the IO's intention to launch a competitive Open Tender process in the coming weeks. This summary provides some basic information about the ITER Organisation, the technical scope for this tender, and details of the tender process for the procurement of the services related to the Absolute Valve Feasibility Study.

1 Introduction

This Prior Indicative Notice (PIN) is the first step of an Open Tender (OT) Procurement Process leading to the award and execution of up to two Service Contracts.

The purpose of this document is to provide a basic summary of the technical content in terms of the scope of work, and the tendering process.

2 Background

The ITER project is an international research and development project jointly funded by its seven Members being, the European Union (represented by EURATOM), Japan, the People's Republic of China, India, the Republic of Korea, the Russian Federation and the USA. ITER is being constructed in Europe at St. Paul–Lez-Durance in southern France, which is also the location of the headquarters (HQ) of the ITER Organization (IO).

For a complete description of the ITER Project, covering both organizational and technical aspects of the Project, visit www.iter.org.

3 Scope of Work

The present tender process is aiming to set up one or two Service Contract(s) for the Feasibility Study for the Neutral Beam Front End Component called Absolute Valve (AV) that is providing isolation between the ITER Vacuum Vessel (VV) and the Beam Line Vessel (BLV).

This component shall provide the primary vacuum containment for this section of the NB system and therefore provides a part of the first confinement barrier of the in-vessel radioactive inventory.

The scope of work (design, analysis & CAD) is the definition of the complete AV design at Conceptual Design maturity level.

It is limited to the AV for Heating Neutral Beam Injector # 1 (HNB1) and HNB2 only.

The AVs are seated on a Trolley Support already developed at Conceptual maturity level by IO. The interfaces with this trolley shall be developed by the contractor; any modifications (adaptations) and improvements of the AV trolley will be admitted under the review and approval of IO.

At the end of the feasibility study, the Conceptual Mechanical Design shall be completed. A NB Conceptual design review meeting will be organised to validate the main strategies for all the systems which compose the AV taking into account the ITER requirements and the NB cell environment.

The contractor shall present and clearly identify the technical proposal in compliance with all requirements defined in the technical specification.

The contractor shall also be able to present potential risks or showstopper of the development of the Valve if any. An IO board will be able to judge the relevance of this kind of statement only based on technical evidences.

The conclusion of this milestone shall permit to go or not to the next step: Preliminary Design Review (PDR).

The work shall be performed off-site.

To be noted that a new procurement for the design finalisation and the manufacturing and test of up to 3 Absolute Valves will follow among the entities who successfully completed a feasibility study.

4 Procurement Process & Objective

The objective is to award one or two Service Contract(s) through a competitive bidding process.

The Procurement Procedure selected for this tender is called the **Open Tender** procedure.

The Open Tender procedure is comprised of the following four main steps:

- Step 1- Prior Information Notice (PIN)

  The Prior Information Notice is the first stage of the Open Tender process. The IO formally invites interested Suppliers to indicate their interest in the competitive process by returning to the Procurement officer in charge the attached "Expression of Interest and PIN Acknowledgement" by the date indicated under the procurement timetable.

  Special attention:

  Interested tenderers are kindly requested to register in the IO Ariba e-procurement tool called "IPROC". You can find all links to proceed along with instruction going to: https://www.iter.org/fr/proc/overview.

  When registering in Ariba (IPROC), suppliers are kindly requested to nominate at least one contact person. This contact person will be receiving the notification of publication of the Request for Proposal and will then be able to forward the tender documents to colleagues if deemed necessary.

- Step 2 - Invitation to Tender

  After at least 15 working days of the publication of the PIN, normally the Request for Proposals (RFP) will be published on our digital tool "Iproc". This stage allows interested bidders who have indicated their interest to the Procurement Officer in charge AND who have registered in IPROC to receive the notification that the RFP is published. They will then prepare and submit their proposals in accordance with the tender instructions detailed in the RFP.

  Only companies registered in this tool will be invited to the tender.

- Step 3 – Tender Evaluation Process

  Tenderers proposals will be evaluated by an impartial evaluation committee including IO and F4E members. Tenderers must provide details demonstrating their technical compliance to perform the work in line with the technical scope and in accordance with the particular criteria listed in the RFP.

- Step 4 – Contract(s) Award

  One or two Service Contract(s) will be awarded on the basis of the Best Value For Money methodology according to the evaluation criteria and methodology described in the RFP.

Procurement Timetable

The tentative timetable is as follows:

Milestone	Date
Publication of the Prior Indicative Notice (PIN)	23th February 2024
Submission of expression of interest form	15th March 2024
Invitation to Tender (ITT) advertisement	31st March 2024

Clarification Questions (if any) and Answers	29th April 2024
Tender Submission	13th May 2024
Tender Evaluation & Contract(s) Award	28th June 2024
Contract(s) Signature	July 2024

5 Quality Assurance Requirements

Prior to commencement of any work under this Contract, a "Quality Plan" shall be produced by the Supplier and submitted to the IO for approval, describing how they will implement the ITER Procurement Quality Requirements.

6 Contract Duration and Execution

The ITER Organization shall award the Service Contract around June 2024. The estimated contract duration shall be 10 months.

7 Experience

The tenderer shall demonstrate their technical and industrial experience related to the scope of work as detailed in Annex I.

The working language of ITER is English, and a fluent professional level is required (spoken and written).

8 Candidature

Participation is open to all legal entities participating either individually or in a grouping/consortium. A legal entity is an individual, company, or organization that has legal rights and obligations and is established within an ITER Member State, being, the European Union (represented by EURATOM), Japan, the People's Republic of China, India, the Republic of Korea, the Russian Federation and the USA.

Legal entities cannot participate individually or as a consortium partner in more than one application or tender of the same contract. A consortium may be a permanent, legally established grouping, or a grouping which has been constituted informally for a specific tender procedure. All members of a consortium (i.e. the leader and all other members) are jointly and severally liable to the ITER Organization.

In order for a consortium to be acceptable, the individual legal entities included therein shall have nominated a consortium leader with authority to bind each member of the consortium, and this leader shall be authorised to incur liabilities and receive instructions for and on behalf of each member of the consortium.

It is expected that the designated consortium leader will explain the composition of the consortium members in its offer. Following this, the Candidate's composition must not be modified without notifying the ITER Organization of any change. Evidence of any such authorisation to represent and bind each consortium member shall be submitted to the IO in due course in the form of a power of attorney signed by legally authorised signatories of all the consortium members.

Any consortium member shall be registered in IPROC.

All legal entities who already performed a feasibility study for the absolute valve described in the technical specification ID: ITER_D_9GUSMN will not be considered eligible to take part to this Open Tender process.

9 Sub-contracting Rules

All sub-contractors who will be taken on by the Contractor shall be declared together with the tender submission. Each sub-contractor will be required to complete and sign forms including technical and administrative information which shall be submitted to the IO by the tenderer as part of its tender.
The IO reserves the right to approve any sub-contractor which was not notified in the tender and request a copy of the sub-contracting agreement between the tenderer and its sub-contractor(s).
Sub-contracting is allowed but it is limited to one level and its cumulated volume is limited to 30% of the total Contract value.

IDM UID
9GUSMN

VERSION CREATED ON / VERSION / STATUS
30 Jan 2024 / 1.3 / Approved

EXTERNAL REFERENCE / VERSION

Technical Requirements Specification

TS_AV_Feasibility_study

Technical Specification for the feasibility study of the Absolute Valve in the frame of the new procurement strategy

Approval Process			
	Name	*Action*	*Affiliation*
Author	**Urbani M.**	**30 Jan 2024:signed**	**IO/DG/CP/HCD/NB**
Co-Authors			
Reviewers	**Agarici G.** **Beaudoin V.** **Rondinella E.** **Veltri P.** **Vertongen P.**	**31 Jan 2024:recommended** **05 Feb 2024:recommended** **31 Jan 2024:recommended** **30 Jan 2024:recommended (Short Cycle)** **30 Jan 2024:recommended**	**F4E (EU)** **IO/DG/SQD/NS/NSA** **IO/DG/ADM/PRD/ESOC/PACD** **IO/DG/CP/HCD/NB** **IO/DG/SQD/QMD/QA**
Approver	**Boilson D.**	**05 Feb 2024:approved**	**IO/DG/CP/HCD**
Document Security: Non-public - Unclassified *RO: Urbani Marc*			
Read Access	**LG: F4E_NB_PS, AD: ITER, AD: External Collaborators, AD: IO_Director-General, AD: External Management Advisory Board, AD: IDM_Controller, AD: OBS - Neutral Beam Project (NB) - EXT, AD: OBS - Neutral Beam Project (NB), AD: Auditors, AD: ITER Management Assessor, project administrator, RO**		

Change Log			
TS_AV_Feasibility_study (9GUSMN)			
Version	***Latest Status***	***Issue Date***	***Description of Change***
v1.0	Signed	16 Oct 2023	
v1.1	Approved	21 Nov 2023	Revision taking into account F4E comments
v1.2	In Work	30 Jan 2024	version with reference [40] removed
v1.3	Approved	30 Jan 2024	version without reference [40].

Table of Contents

1 Abstract

ITER is a joint international research and development project that aims to demonstrate the scientific and technical feasibility of fusion power.

In southern France, 35 nations* are collaborating to build the world's largest tokamak, a magnetic fusion device that has been designed to prove the feasibility of fusion as a large-scale and carbon-free source of energy based on the same principle that powers our Sun and stars.

Thousands of engineers and scientists have contributed to the design of ITER since the idea for an international joint experiment in fusion was first launched in 1985. The ITER Members—China, the European Union, India, Japan, Korea, Russia and the United States—are now engaged in a 35-year collaboration to build and operate the ITER experimental device, and together bring fusion to the point where a demonstration fusion reactor can be designed.

ITER will be the first fusion device to produce net energy. ITER will be the first fusion device to maintain fusion for long periods of time. And ITER will be the first fusion device to test the integrated technologies, materials, and physics regimes necessary for the commercial production of fusion-based electricity.

The Neutral Beam system for ITER consists of two heating and current drive (H&CD) NB injectors and a diagnostic neutral beam (DNB) injector. The layout allows a possible third HNB injector to be installed later. These NB injectors will be connected to equatorial ports #4 - #6 for the H&CD NBs. The DNB shares port #4 with the H&CD NB. The injectors will be located outside the cryostat inside a common enclosure, the NB cell, on north side of the Tokamak building in the L1 and the L2 levels. As they are directly coupled to the ITER vacuum vessel, the injectors are extensions of the primary confinement barrier of radioactive materials coming from the vacuum vessel. The NB cell will form the secondary confinement barrier.

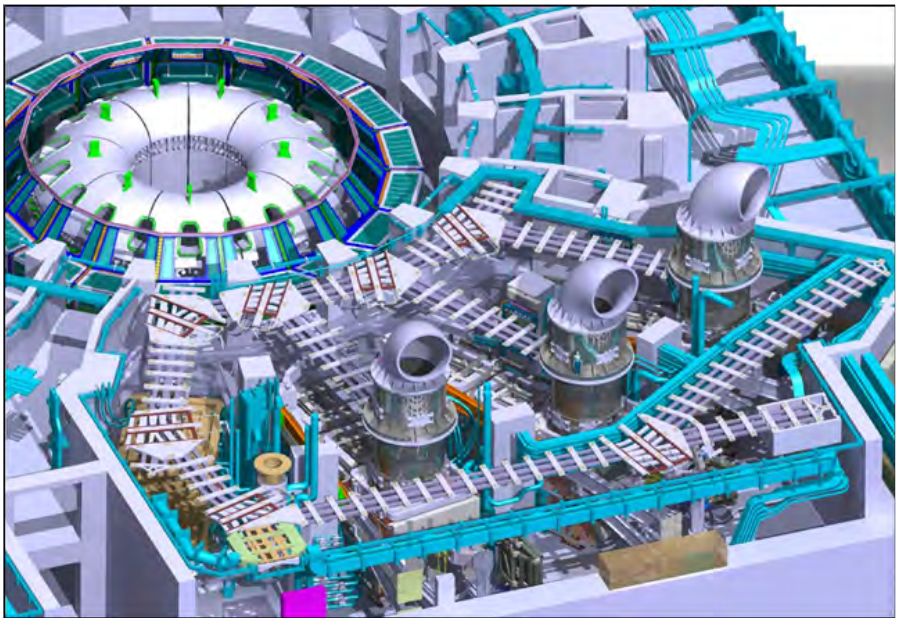


Figure 1: Isometric view of the NB Cell

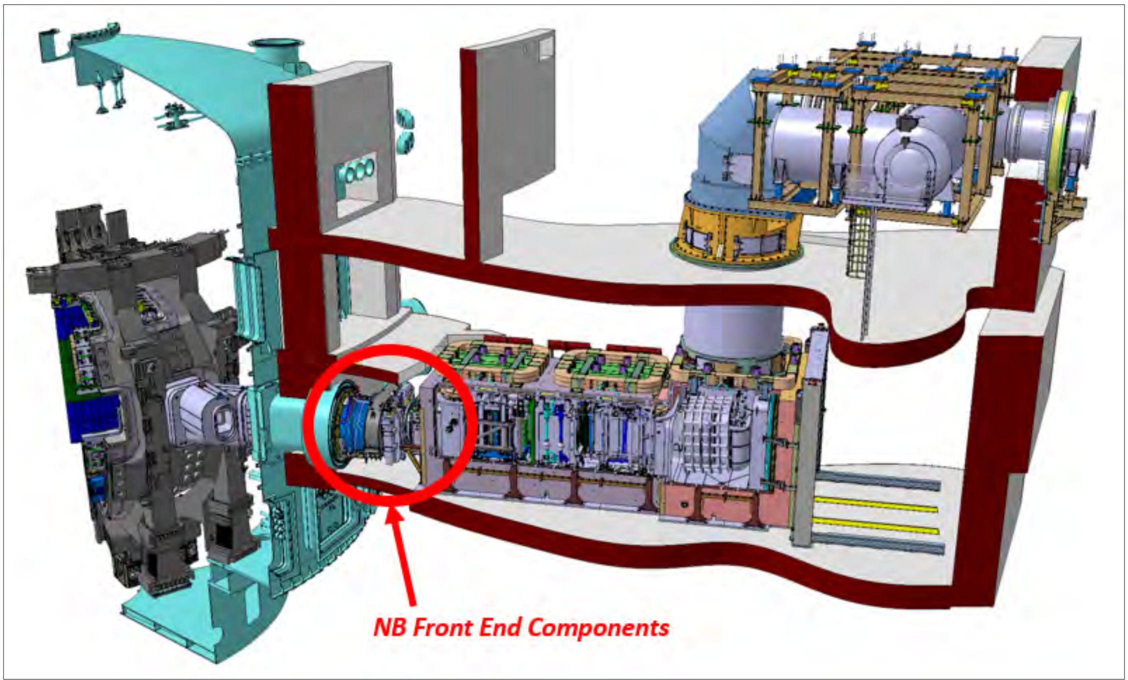


Figure 2: Cross section of one Heating Neutral Beam Injector

Each NB injectors is connected to the Torus primary vacuum via the Absolute Valve that provides isolation between the ITER VV and the BLV.

This component **shall** provide the primary vacuum containment for this section of the NB system and therefore provides a part of the first confinement barrier of the in-vessel radioactive inventory.

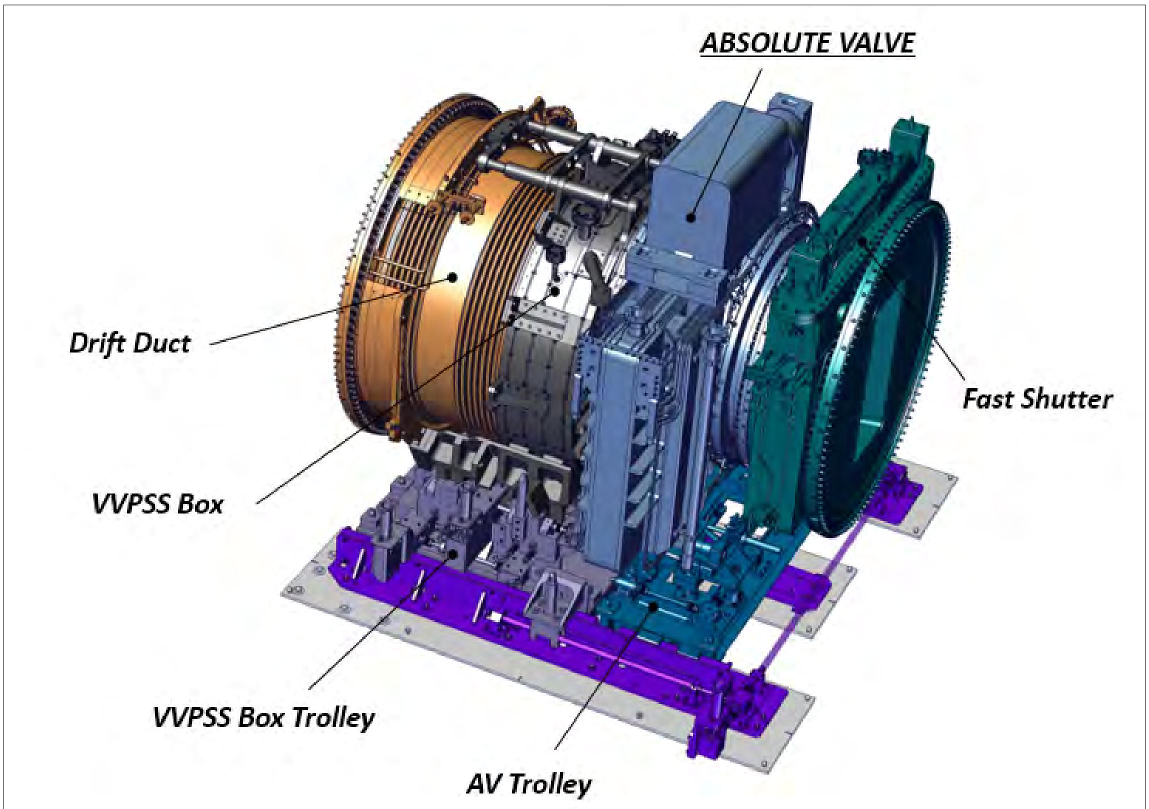


Figure 3: NB Front End Components

2 Purpose & Objective

The purpose of the document is to define all ITER requirements that permit to carry out a feasibility study of the Neutral Beam Front End Component called Absolute Valve.

During this feasibility study, the contractor **shall** develop the AV design in accordance with IO requirements in order to validate the Conceptual Design of the Absolute valve.

A technical meeting called Conceptual Design Review in accordance with IO procedure [1] will determine the suitability of the design proposal.

The objective of the feasibility study is to complete the Conceptual Design (that is concluded by the CDR) of the AV in order to be able to launch the following phases: Preliminary Design and Final Design .

3 Scope

The scope of work (design, analysis & CAD) is the definition of the complete AV design at Conceptual Design maturity level.

The scope of the work is limited to the Absolute Valve for Heating Neutral Beam Injector # 1 (HNB1) and HNB2 only. Moreover, the HNB1 and HNB2 Absolute Valves will have to be similar, except for what concerns the symmetry and the connection with the water pipes.. Only the compliance with the environment of the NB cell obliges to have two different implementations of the Absolute Valves. This implies to have a symmetrical design of the valve with a different connection of the water pipes for the remote handling access.

The AVs are seated on a Trolley Support already developed at Conceptual Design level by IO. The interfaces with this trolley **shall** be developed by the contractor; any modifications (adaptations) and improvements of the AV/trolley interfaces will be admitted under the review and approval of IO.

At the end of the feasibility study, the Conceptual Mechanical Design **shall** be completed. A NB Conceptual Design Review (CDR) meeting will be organised by IO to validate the main strategies for all the systems which compose the AV taking into account the ITER requirements and the NB cell environment.

At CDR, the contractor **shall** present and clearly identify the technical proposal in compliance with all requirements defined in the document.

At CDR, the contractor **shall** also be able to present potential risks or showstopper of the development of the Valve if any. An IO board will judge the relevance of the risks (including showstopper) only based on technical evidences presented by the contractor.

The conclusion of this milestone **shall** permit to go or not to the next step: Preliminary Design (PD).

4 Acronyms

4.1 Acronyms

The following acronyms are the main one relevant to this document.

The abbreviations use in this document are explained in the following list:

AAR	Accident Analysis Report
ACCC	Active Compensation Cooled Correction Coils
ASCE	American Society of Civil Engineers
ASME	American Society of Mechanical Engineers
AV	Absolute Valve
BLC	Beam Line Components
BS	Beam Source
BLV	Beam Line Vessel
BSV	Beam Source Vessel
CDR	Conceptual Design Review
DA	Domestic Agency
DD	Drift Duct
DDD	Design Description Document
DOF	Degree Of Freedom
DRS	Design Response Spectra
EM	Electro Magnetic
ESP	French decree dated December 13, 1999 related to the manufacture of pressure equipment (Implementation of the European Pressure Equipment Directive 97/23/EC PED in French law).
ESPN	French order dated December 12, 2005 related to the manufacture of Nuclear Pressure Equipment (NPE)
FEC	Front End Component
FRS	Floor Response Spectra
FS	Fast Shutter
HNB	Heating Neutral Beam
H&CD	Heating & Current Drive
ICE	Ingress of Coolant Event
IO	ITER Organization
kN	Kilo Newton
LOCA	Loss of Coolant Accident
LOFA	Loss of (forced) Flow Accident
LOOP	Loss Of Off-site Power
LOVA	Loss of Vacuum Accident

MD	Major Disruption
MFD	Magnet Fast (current) Discharge
MN	Mega Newton
MPa	Mega Pascal
MQP	Management Quality Program
NB	Neutral Beam
NBI	Neutral Beam Injector
NBFECTS	Neutral Beam Front End Components Trolley Support
NRC	Nuclear Regulatory Commission
NSC	Non-Seismic Class
PA	Procurement Arrangement
	PBS: Project Breakdown Structure PCR: Project Change Request
PR	Project Requirement (Document)
PHTS	Primary Heat Transfer Systems
PRS	Point Response Spectra - Spectra calculated at specific points of a structure (also called "In-Structure Spectra" and "Secondary Spectra
RD	Rupture Disk
RH	Remote Handling
RPrS	Preliminary Safety Report (Rapport Préliminaire de Sûreté)
SC	Seismic Class
SIC	Safety Importance Class (-1 or -2)
SL	Seismic Level
SL-1	Seismic Level 1 – Defined by ITER for investment protection
SL-2	Seismic Level 2 – equivalent to Safe Shutdown Earthquake
SMHV	Séismes Maximaux Historiquement Vraisemblables = Maximum Historically Probable Earthquakes
SRD	System Requirement Document
SRSS	Square Root of Sum of Square
SSE	Safe Shutdown Earthquake
ST	Suppression Tank
ST-VS	Suppression Tank Venting System
SVS	System Vacuum Service
TGCS	Tokamak Global Coordinate System
TRO	Technical Responsible Officer
VDE	Vertical Displacement Event
VV	Vacuum Vessel
VVPSS	Vacuum Vessel Pressure Suppression System
ZPA	Zero Period Acceleration

For a complete list of ITER abbreviations see: ITER Abbreviations (2MU6W5).

5 Applicable and Reference Documents

This is the responsibility of the Contractor to identify and request for any documents that would not have been transmitted by IO, including the below list of reference documents.

This Technical Specification takes precedence over the applicable and reference documents. In case of conflicting information, this is the responsibility of the Contractor to seek clarification from IO.

Applicable Document are those documents containing provisions that constitute mandatory requirements of the task imposed by ITER Organisation.

ADs are binding in the implementation of the task , and therefore evidence of compliance by the Contractor is required.

Reference documents are documents containing information and/or data for consultation, useful in enhancing understanding of a given subject, and putting the Applicable Documents in the right and understandable context. Reference Documents are not binding and therefore evidence of propagation or compliance is not expected.

5.1 Applicable Documents

Upon notification of any revision of the applicable document transmitted officially to the Contractor, the Contractor **shall** advise within 4 weeks of any impact on the execution of the contract. Without any response after this period, no impact will be considered.

[2] ITER_D_LAMFG2 - Defined requirements for PBS53 V4.5

[3] RCC-MR- RCC-MR code, edition to be chosen by the supplier.

[4] ITER_D_222RHC - In-vessel Components, SDC-IC V3.0

[5]ITER_D_4GN7KX - IS-53-31-009-HNB-Absolute Valve of the HNB injectors V1.6

[6] ITER Vacuum Handbook: ITER_D_2EZ9UM - ITER Vacuum Handbook V2.5

[7] ITER_D_44ZMKX - HNB/DNB Absolute Valve Loads Specification V8.1

[13] ITER Remote Handling Code of Practice (RHCOP) - ITER_D_2E7BC5 v1.2

[15] ITER_D_6WL76W - Draining of the HNB Front Components cooling circuits

[17] Vacuum Handbook Appendix 12 Leak Testing link ITER_D_2EYZ5F - Appendix 12 Leak Testing

[20] ITER_D_X5EYSK - NB FEC Trolley Support Load Specification v3.0

[21] ITER_D_VT29D6 - Instructions for Seismic Analyses V2.0

[22] ITER_D_35BVV3 - Instructions for Structural Analyses V4.0

[23] ITER_D_22MAL7 - Procedure for Analyses and Calculations V6.6

[24] ITER_D_VQVTQW - Template for Structural Analysis Reports V1.0

[25] ITER_D_KTU8HH - Software Qualification Policy V2.0

[27] ITER_D_VAET99 - Template for Seismic Analysis Reports V1.0

[28] ITER_D_VUEEDB - Instructions for Computational Fluid Dynamics Analyses V2.0

[29] ITER_D_TL7H73 - Template for CFD analysis reports V1.1

[30] ITER_D_U34WF3 - Instructions for the Storage of Analysis Models V2.0

[33] Surveillance plan for PBS 53 Annex 2: Detailed List of PIAs ITER_D_U65RWF V1.2

[35] ITER_D_SBSTBM - Provisions for Implementation of the Generic Safety Requirements by the External Interveners V2.2

[36] ITER_D_REYV5V - Chemical composition and impurity requirements for materials V2.3

[37] CATIA Model of the present AV including its environment, RH reservation, and adjacent components (Fast Shutter, Trolley, NB VVPSS Box)- DET XXX (DET not available – IO shall provide it before the signature of the contract)

[43] ITER_D_4ZQVXE V1.3 - IS-26.CC-53-002 Interface Sheet Component Cooling Water system (PBS26.CC.2B)-Neutral Beam H&CD system (PBS53)

[44] ITER_D_SBYJXD - Guideline for Identification of the Protection Important Activities (PIA)

[45] ITER_D_82MXQK - General Management Specification for Service and Supply V1.4

5.2 Reference Documents

[1] ITER_D_2832CF - Design Review Procedure (V6.4[2] ITER_D_LAMFG2

[8] Safety Important Functions and Components Classification Criteria and Methodology, ITER_D_347SF3 V1.8

[9] ITER Seismic Nuclear Safety Approach, ITER_D_2DRVPE

[10] Quality Classification Determination, ITER_D_24VQES

[11] ITER Remote Maintenance Management System, ITER_D_2FMAJY

[12] [TRC] - Tritium classification - ITER_D_34PRS4

[14] ITER_D_9YCL9N - DDD 23.05 APPENDIX A - Design of the Monorail Crane..]

[16] ITER_D_27ZRW8 - Project Requirements (PR)

[18]PDF and TDF: ITER_D_3P4WSB - TDF-23-53-00XX-HNB_Absolute valve_V1.0

[19]VR Simulation for HNB Absolute Valve: ITER_D_4C63BU

[31] ITER_D_3ZR2NC - Preliminary Safety Report (RPrS) – section I-9.5 Magnetic zoning

[34] Order dated 7 February 2012 relating to the general technical regulations applicable to INB

[38] ITER_D_4C6EHL - IS-53-31-007-HNB-Service Vacuum System for the HNB v2.2

[40] Not used

[42] ITER_D_2LJ9V5 V2.2 - ICD-31-53 Vacuum Neutral Beams

6 Scope of Work

The conceptual mechanical design (CMD) is constituted of:

- Conceptual Mechanical Design Model limited to 3D models and 2 D drawings (showing the integration of the Valve systems in the environment etc.),and does not extend to the level of details typically found in 2-D Built-To-Print drawings.
- Supporting documentations and preliminary calculation report. The contractor **shall** present with technical evidences (3D models, schemes, preliminary analysis) that the strategy of the technical proposals is compliant with the NB environment and ITER requirements (main functions defined in this document); feasibility **shall** be demonstrated and assessment of the risks **shall** be provided in order to complete the Conceptual Design Phase.

During this phase, the work defined in this document **shall** have to be undertaken with the following ITER recommendations:

- Respect of the NB cell environment and NB Front End components (neighbouring system)
- Respect of the Defined Requirements [2]

With respect to Safety, Safety requirements **shall** be considered in its design and in particular to its joining or sealing proposals (For instance: Type and definition of welds).

6.1 Code and Standards

6.1.1 First Confinement barrier

For metallic parts which form the first confinement barrier of plasma vacuum chamber it is proposed to use a Nuclear Code.

This code **shall** be used for nuclear pressure and for other components, which are non-pressure equipment. The proposed Nuclear Code is RCC-MR (edition to be chosen by the supplier- class 2) [3].

The supplier may propose other Nuclear code equivalent to RCC-MR code that will be subjected to IO approval (*).

Using this code has some benefits for licensing of the ITER plasma chamber which provide first confinement. These advantages are:

- Reduction of risk with delay of licensing ITER facility

- Unification of technical procedures for connections of various components

- Simplification of interface requirements

(*) *If the supplier encounters technical showstoppers on the design following the RCC-MR code, it shall be clearly identified and justified to IO. IO shall accept the need of deviation to the code with the prerequisite that IO approve the justification of the issue. The deviation will be raised by the supplier. IO shall approve the deviation with the prerequisite that the supplier develops a mitigation/qualification procedure compliant with the regulations*

6.1.2 *Non-First Confinement barriers*

The Internal, non-first confinement boundary parts of this component **shall** be designed to SDC-IC [4].

SDC-IC consists of the main Design Criteria document and annexed appendixes.

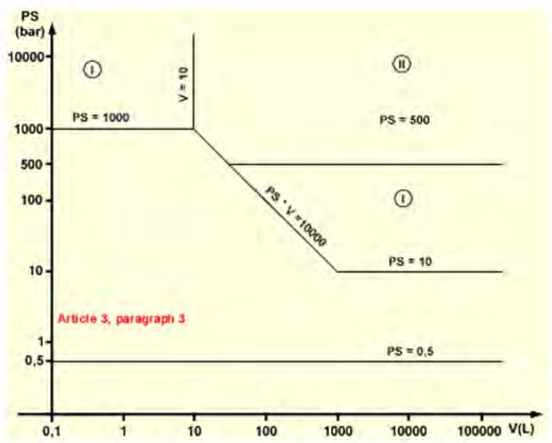
The main document includes definitions and classifications of different damage and failure modes, type of stresses, joints, thermal creep phenomena, buckling, etc. The other parts of document include design rules for general single layer homogeneous structures at low and elevated temperatures, rules for welded joints and rules for bolts. Design rules for multilayer heterogeneous structures are included also, but they are limited to only low temperature application.

- Appendix A, Materials Design Limit Data, currently includes the material properties data.
- Appendix B, Guideline for Analysis, provides analysis methods and guidelines of the design rules of SDC-IC.[4]
- Appendix C, Rationale or Justification of the Rules, includes the background information including references to literature that provided the foundation for the rules proposed in the SDC-IC.[4]

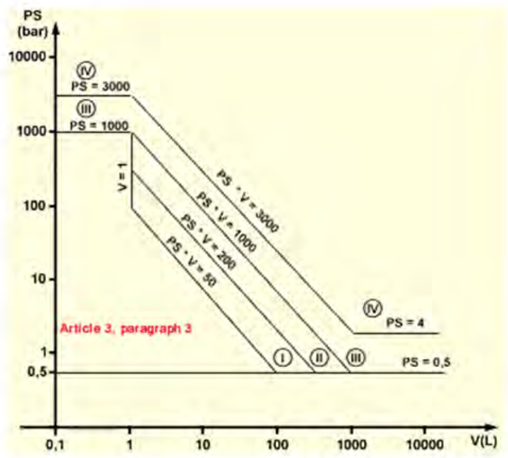
6.1.3 *PED/ESPN Requirements*

- The design of the AV **shall** comply with the requirements of ESP/ESPN. Note that in the context of ESP and ESPN the pressure designation 'PS' is here taken to be equivalent to the Maximum Allowable Working Pressure (MAWP).
- Note that embedded coolant pipes that have a heat exchange function are classified as 'vessels' in the context of ESP/ESPN.
- Note that if the coolant temperature exceeds 110˚C, the coolant is classed as a gas.

The graphs below allow the correct classification of the coolant pipework to be determined:



Vessels containing group 2 **liquids**



Vessels containing group 2 **gases**

The AV s**hall** be designed to be cooled, drained, and dried under PED (**) class 0 or max class 1 (*to avoid any requalification/inspection during lifetime of the valve*)

(**): *The Pressure Equipment Directive (PED) was adopted by the European Parliament and the European Council in May 1997. From 29 May 2002 the PED is obligatory throughout the*

European Union. The directive provides, together with the directives related to simple pressure vessels (87/404/EC), for an adequate legislative framework on European level for equipment subject to a pressure hazard.

Following this European Directive the French Decree 99-1046, 13th December 1999 concerning pressure equipment (Amended by Decree No. 2003-1249 dated 22nd December 2003, by Decree No. 2003-1264 dated 23rd December 2003 and Decree 2007-1557 dated 2nd November 2007 and Decree 2010-882 dated July 27, 2010) and French Order dated 21st December 1999 concerning the classification and evaluation of the conformity of pressure equipment put the PED in force in France. Acronym ESP is proposed to be used for above mentioned documents.

6.1.4 Vacuum boundary

In case the First Confinement barrier is also a Vacuum Barrier it also **shall** comply with the ITER Vacuum Handbook [6].

The AV is Vacuum boundary. The AV design **shall** comply with the IS 53-31 [5] which defines the interface between the PBS 53 (Neutral Beam) and PBS 31 (Vacuum Section) for all the NB injectors

Independent vacuum in the HNB Vessel can be created when the AV is closed, which allows independent ITER (plasma) operation even with failure on the NB system side .

The design principal of the AV is a double contained design with metallic seal on each sealing face. The interspace between the twin plates will be differentially pumped to limit the overall valve conductance to an acceptable level. The pumping of the interspace will be provided by a dedicated pumping system provided by PBS 31 (ITER Vacuum Section). A stub of DN 100 schedule 10 **is** included in the casing of the AV to connect to the interspace. A flange on the pumping line close to the Absolute Valve in the NB cell **is** implemented so that an additional pump could be installed if very low pressures are found to be required.

All other double containment interspaces (between static gasket, between double bellows, etc) of the absolute valve **shall** be serviced by the Service Vacuum System [38]

The casing of the AV **shall** have a maximum allowable leak rate of 1E-10 Pa.m^3/s air equivalent from exterior atmosphere to internal vacuum.

Sealing for the first confinement boundary **shall** be by either:

- Welding (compliant with RCC-MR [3] code and Vacuum Handbook [6]
- Metallic seal rings.

All components that have vacuum barrier(s) or/and are located inside vacuum **shall** comply with the vacuum handbook [6].

The maximum leak rates of the AV for the different scenarios are defined as follows:

A. ITER Vacuum Vessel (VV) under vacuum and the NB Vessel at 0.1 MPa

   Overall maximum leak rate 10^{-8} Pa·m^3/s

   In the case of a double contained design: Sufficient single leak rate with pumped interspace 10^{-5} Pa·m^3/s at a pressure difference of 0.1 MPa

B. ITER VV at 0.1 MPa and the NB Vessel under vacuum

Overall maximum leak rate 10^{-8} Pa·m^3/s

In the case of a double contained design: Sufficient single leak rate with pumped interspace 10^{-5} Pa·m^3/s at a pressure difference of 0.1 MPa

C. Regeneration of the cryopump: ITER VV under vacuum and NB Vessel at 2000 Pa

Overall maximum leak rate 10^{-2} Pa·m^3/s

In the case of a double contained design: Sufficient single leak rate with pumped interspace 10 Pa·m^3/s at a pressure difference of 0.1 MPa

6.2 AV Conceptual Study

6.2.1 Design Requirements

6.2.1.1 General functional requirements

Each NB injectors is connected to the Torus primary vacuum via the Absolute Valve that provides isolation between the ITER VV and the NB Vessel. This component **shall** provide the primary vacuum containment for this section of the NB system (see section 6.1.4) and therefore provides a part of the first confinement barrier of the in-vessel radioactive inventory.

The key functional requirements of the Absolute Valve are defined as below:

- The AV **shall** provide isolation of the NB H&CD system during any failure of Internal NB components: Independent vacuum in the NB Vessel can be created when the valve is closed, which allows the independence of the faulted NB system vs. the ITER device itself. This facilitates isolation of the torus vessel vacuum from that of the neutral beam vessel, enabling venting of either Vessels to atmosphere in order to continue ITER operations

- The AV **shall** maintain a maximum leak rate for absolute sealing across two sealing plates and interspace pumping of 1.10-8 Pa.m3/s for 100 cycles at a pressure difference of one atmosphere (see Section 6.1.4).

- The AV casing **shall** provide first confinement functionality in all operational valve states. This functionality is also required under normal & upset operating conditions and is maintained during emergency and faulted scenarios to prevent releases in excess of the guidelines established for accidents.

- The AV together with the Fast Shutter **shall** isolate the NB Vessel from the ITER VV in order to enable maintenance operations on the NB side (ITER VV under depression – no absolute sealing is required)

- The AV **shall** withstand the loads defined in the LS with the compliant criteria associated [7]

- The AV design **shall** accommodate of the NB Cell environment.

- The AV Sub-systems defined a vacuum boundary **shall** be Vacuum compatible (in accordance with [6] .

- The AV **shall** withstand the NB re-ionisation heat load section 2.7 of [7] [5]

- The AV **shall** be designed to achieve 20 years of lifetime (chemical & irradiation degradation).

- The AV **shall** be compliant Nuclear containment boundary requirements as first confinement barrier of the in-vessel radioactive inventory.
- High reliability of the AV sub-systems **shall** be ensured.
- The design of the AV **shall** be qualified to meet regulatory safety requirements (RCC-MR – see section 6.1.1)
- The design of the AV **shall** allow the maintenance of the NB line components
- The AV **shall not** impede maintenance access to the upper ports #4, 5, 6 & 7.

The technical function of the isolation of the AV are also defined in the section 1.5.3 of the AV Load Specification [7]

6.2.1.2 Description of the current design and additional technical requirements

A current design of the AV has been developed the past 10 years, The contractor will be able to start his study based on the current ITER design except the parts covered under IP. This will be defined in this document.

The valve design is currently a pendulum type valve with a nominal bore dimension of 1600 mm and an axial length of 760 mm between the outer faces of the casing. The overall width of the valve is 3120 mm with edge of the rectangular pocket being 2140 mm from the axis of the valve bore. The overall height is around 3 m. The valve plate is suspended from a pendulum and carries a pair of all-metal seal rings.

Basically, the AV current design can be split in sub-systems defined as below:

- Sub-system 1: Sealing System
- Sub-system 2: Valve plate
- Sub-system 3: Casing & Interfacing flanges
- Sub-system 4: Plate actuator system
- Sub-system 5: Seal Protection System
- Sub-system 6: Locking system
- Sub-system 7: I&C work package
- Sub-system 8: Trolley support of the AV

The contractor will have access to the current ITER AV design under the frame of the IP limitation. The re-use of this sub-systems division is not mandatory; the contractor can propose any suitable design and sub-systems compliant with the ITER requirements defined in this document.

The valve is connected to the Fast Shutter and to the VVPSS box. Both these interfaces consist of similar flanges with a bore diameter of 1,600 mm to a standard design compatible with the NB cell RH equipment. The valve is also supported from beneath by means of a trolley which bears its weight, but with sufficient compliance to accommodate thermal expansion of the valve without transferring significant loads across the flange interfaces.

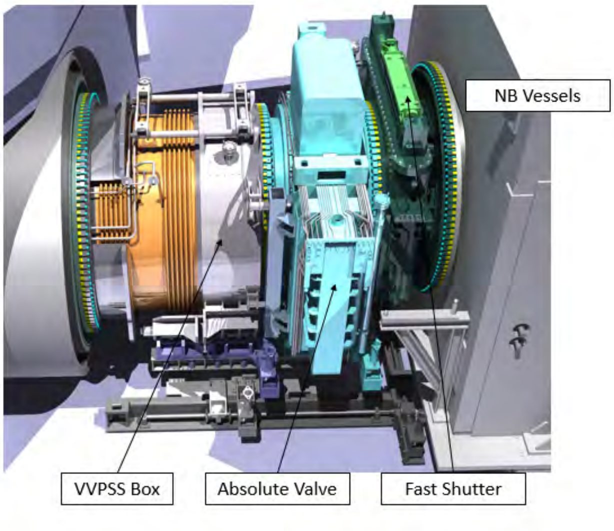


Figure 4: HNB Front End Components integration

The AV interfacing flanges (*Sub-system 3*) **shall** be compatible with:

- the VVPSS Box flange for the HNB / Drift Duct for the DNB on one side
- the Fast Shutter flange on the other side.

The sealing solution adopted by IO and the RH requirements for these two pairs of flanges has been defined, along with associated remote handling procedures and tooling. The interfaces flanges design have already been frozen. The Absolute Valve **shall** integrate these interfacing flanges with the sealing system already defined by IO (HELICOFLEX Seals – see figure 5).

In the current design of the AV, the flanges interface with the 2 neighbouring components are identical.

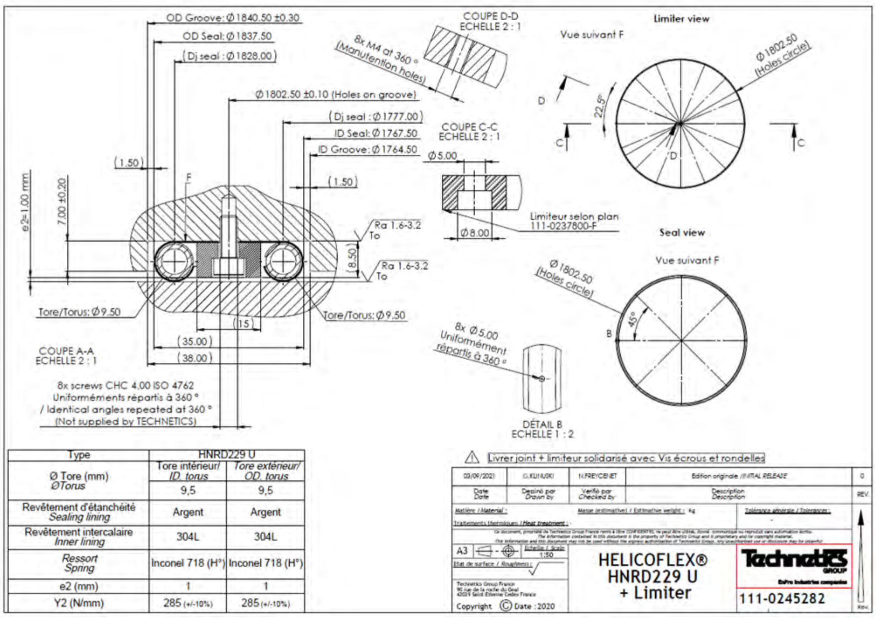


Figure 5: Sealing interface between the Fast Shutter and the VVPSS Box with the Absolute Valve

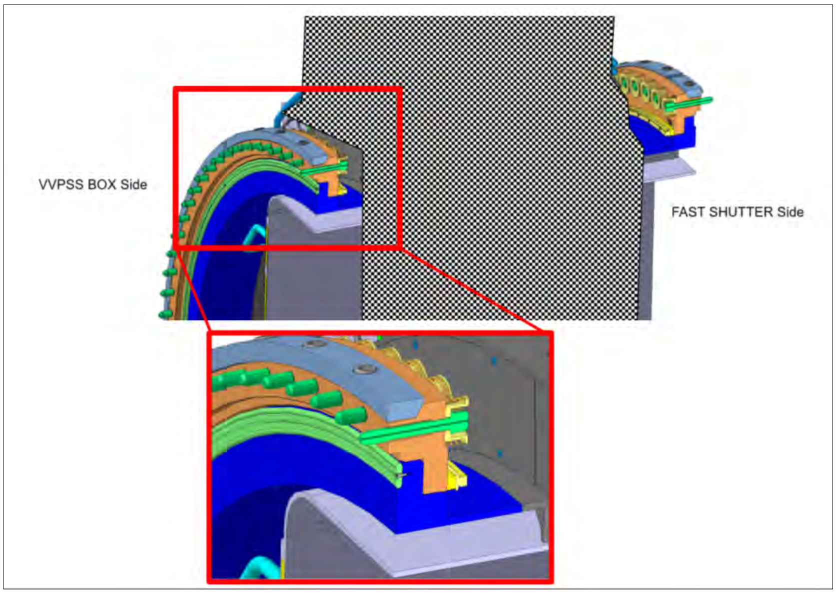


Figure 6: Sealing interface between the Fast Shutter and the VVPSS Box with the Absolute Valve preliminary design

Design of the flanges at the interfaces is provided by ITER in the Catia Model [37].

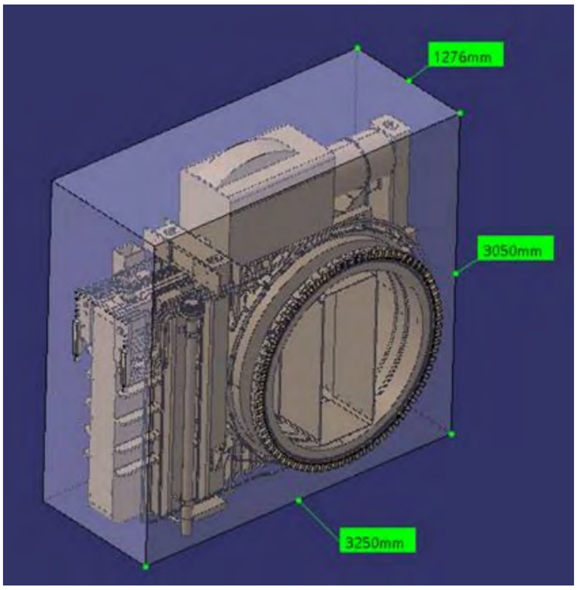


Figure 7: maximum envelope of the Absolute Valve

The maximum space envelope of the Absolute Valve integrated in the NB cell environment **shall** be : 3250 mm by 3000mm (locally 3050 mm) by 1276mm (see figure 7)

The maximum Weight of the AV **shall** be less than 9 000 kg.

The AV services include:

- coolant from the NBI PHTS (see section 6.2.1.8)
- system, pneumatic actuator “air” lines,
- Power-electric connections from casing and seal seat ring heating systems
- Connections for C&I systems.

The AV will be connected to the Service Vacuum System in order to monitor any interspaces used for double seals, double bellows, etc , when needed.

6.2.1.3 Classification of the AV

The Absolute Valve comes under the following classifications:

- **Safety Important Functions and Components Classification Criteria [8]: see table 1**(1)
- **Seismic Class: SC(1) SF [9]** (2)
- **Quality: class 1 [10]**
- **Vacuum Quality Classification [6] : see table 2**
- **Remote handling: RH class 3** (3) **[11]**
- **Tritium class: TC1A [12]**

As the AV current design has been divided in different sub-systems; these sub-systems can be classified independently as defined in table1 below. The classification of some Sub-systems may evolve according to the concept proposed by the contractor: Division can be added or removed; the contractor shall present a new proposal submitted to the review and approval of IO. The sub-systems classification written in red in the table1 cannot be changed.

Items	First Confinement barrier	Vacuum boundary	SIC Classification	Quality class	design code	Manufacturing code
Sub-system 1: Sealing System	NO when AV closed during Plasma operation YES when AV closed during Maintenance operation of RH class 1 & 2 NB components	YES when AV closed during Plasma operation No when AV closed during Maintenance operation	**NON-SIC** when AV closed during Plasma operation **SR** when AV closed during Maintenance operation of RH class 1 & 2 NB components	QC1	SDC-IC	RCC-MR or ASME VIII-Div 2
Sub-system 2: Valve plate	NO when AV closed during Plasma operation YES when AV closed during Maintenance operation of RH class 1	YES when AV closed during Plasma operation No when AV closed during Maintenance operation	**NON-SIC** when AV closed during Plasma operation **SR** when AV closed during Maintenance operation of RH class 1 & 2 NB components		SDC-IC	RCC-MR or ASME VIII-Div 2

	& 2 NB components					
Sub-system 3: Casing & Interfacing Flanges	YES	YES	**SIC-1**		RCC-MR Class2	RCC-MR Class2
Sub-system 4: Plate actuator system	This will depend of the design proposed by the contractor					
Sub-system 5: Seal Protection System	NO	NO for the component itself but as it is cooled the feeding pipes shall be VQC1A	NON-SIC		SDC-IC	RCC-MR or ASME VIII-Div 2
Sub-system 6: Locking system	NO	NO	**SIC-1**		RCC-MR Class2	RCC-MR Class2
Sub-system 7: I&C work package	NO	NO	NON-SIC Except **SIC-2** Related to Locking system		EN standards	EN standards
Sub-system 8: Pack service	NO	NO	NON SIC		EN standards	EN standards
Sub-system 9: Trolley support of the AV	NO	NO	SIC-2		RCC-MR Class2	RCC-MR Class2

Table1 – Classification of Absolute Valve (I)

(1): Systems, structures and components (SSCs) are identified as Safety Importance Class (SIC) based on the consequences of their failure:

Criterion A: Their failure can directly initiate an incident or accident leading to significant risks of exposure or contamination.

Criterion B: Their operation is required to limit the consequences of an incident or accident leading to significant risks of exposure or contamination.

Criterion C: Their operation is required to ensure functioning of SIC components.

- *SIC-1 SSCs are those required to bring and to maintain ITER in a safe state*
- *SIC-2 SSCs are those used to prevent, detect or mitigate incidents or accidents, but not SIC-1 (not required for ITER to reach a safe state)*
- *SR "Safety Relevant" SSCs have some relevance to safety, but their failure will not impact any safety function.*
- *Non-SIC All other SSCs.*

(2) : Seismic classification

SC1 (SF) - Seismic class one-SF: Structural stability and required functional seismic safety performance maintained in the event of an earthquake, The respect of this level of requirement guarantees the level of safety as throughout the normal operation of the equipment. Nevertheless, while taking into account seismic load characteristics, fatigue is not taken into account.

SC1 (S) - Seismic class one-S: Structural stability maintained in the event of an earthquake, i.e. no rupture of piping, no collapse of structures or equipment, limited plastic strain, limited concrete cracking, structural support functions maintained. With this level of requirement, it is possible that a small level of deformation could occur. Consequently, it could be necessary to inspect equipment before re-using it.

(3) : RH Class 3: Maintenance Task probability > 10-6 but < 10-1 (in 20 year period) Plant designed to be RH compatible for maintenance/Maintenance equipment and operation sequences designed prior to machine operations.

As a RH class 3 component, it is a requirement that the valve continue to function adequately throughout the duration of the ITER experimental programme. As such, no maintenance operations on the AV are foreseen. In the event of a failure of the valve or degradation of performance to unacceptable levels, the valve would need to be removed and replaced by a new component. Refurbishment of the valve is not expected.

The operation of maintenance on the AV are:

- replacement of the full AV (RH Class3 shall be done Remotely with no human intervention).

The component shall be equipped with RH interfaces during design development. No periodic maintenance (repairing actions) plan on the AV is foreseen on the AV, this means that the AV is classified as Remote Handling Class3. As it is RH class 3, the only way to maintain the AV is to remove the whole component, in this case, the state will be similar to the state 1 ‘’Transport & Handling’’ ensured only with Remote operations.

The remote handling tooling and features associated with the AV have been designed compliant with [13]

The AV **shall** incorporate lifting features to be used with the NB cell RH crane(s) for installation.

The AV **shall** be designed taking into account the RH removal (RH Class 3) and replacement of the AV, if required.

Remote Removal of this component has been designed to include (as a minimum) inspection of critical areas, disconnection of relevant services, removal of the component from its nominal position and transportation to a transfer cask in a pre-defined position in the NB cell.

The AV **shall** be designed to be compatible with the remote handling maintenance system that has been defined on [13].

The sequences of this recovery scenario imply to close the AV to avoid the contamination of Tritium dust during the operations. The requirement of the leak tightness is not required, the gate shall just limit the displacement of the dust. All the service pack lines of the AV (cooling, pressurized air, SVS …) **shall** be cut and disconnected.

Extra space accessible by the RH manipulator **shall** be required above the valve for service connections.

Component	PED Class	ESPN Nuclear level(*)	Seismic Class	Vacuum Class (1)	Tritium class	RH class
Sub-system 1: Sealing System	NA	NA	1 (SF)	VQC-1A	1A	3
Sub-system 2: Valve plate	NA	NA	1 (SF)	VQC-1A		
Sub-system 3: Casing & Interfacing Flanges	NA	NA	1(SF)	VQC-1A		
Sub-system 4: Plate actuator system	NA	NA	1 (SF)	TBD according to new design		
Sub-system 5: Seal Protection System	0	N3	1 (SF)	VQC-1A		

Sub-system 6: Locking system	NA	NA	1 (SF)	NA		
Sub-system 7: I&C work package	NA	N3	1 (SF)	TBD according to new design		
Sub-system 8: Pack service	NA	NA	1 (SF)	NA		
Sub-system 9: Trolley support of the AV	NA	NA	1 (SF)	NA		

Table2 – Classification of Absolute Valve (II)

- Any coolant piping of this component that is exposed to the primary vacuum has vacuum class VQC 1A [6].

6.2.1.4 Sub-System 1: Sealing System specific requirements

- The contractor **shall** present a clear proposal of a full metallic sealing system:

In order to comply with the Vacuum boundary requirement (see section 6.1.4) and the first confinement barrier of the in-vessel radioactive inventory requirements, the sealing system **shall** be a full metallic system.

The technology and engineering of an all metal gate valve with a diameter of 1.6 m, s**hall** be compliant with high vacuum, with the required maximum leak rate when sealed of 1×10^{-8} $Pa/m^3/s$.

The sealing system **shall** withstand accidental over pressurisation to 0.2 MPa.

As the plate and seals become first confinement barrier, they **shall** withstand cat III load cases defined in the LS [7].

A seal actuation system may be used to drive the compression of the seals; this system **shall** be compliant to the technical requirements defined in this document.

6.2.1.5 Sub-System 2: Valve plate

- The contractor **shall** present a clear proposal of a Valve plate:

It **shall** be capable of bearing a pressure differential of up to 0.2 MPa in upset operating conditions. This load case (valve closed) is clearly identified in the LS [7]

To protect the plate from the plasma radiation load, water cooled heat shield **shall** be added to the downstream, plasma facing, side.

6.2.1.6 Sub-System 3: Casing and interfacing flanges

The contractor **shall** present a clear proposal of a casing (including interfacing flanges) compliant with the NB cell environment:

The valve casing **shall** provide first confinement functionality in all operational valve states. This functionality is also required under normal & upset operating conditions and **shall** be maintained during emergency and faulted scenarios to prevent releases in excess of the guidelines established for accidents. The Absolute Valve (overall envelope – casing) shall ensure the confinement for tritium

The integration of the Absolute Valve in the Beam line **shall** not result in any significant constraint of the casing against thermal expansion.

The casing and flanges **shall** withstand the combination loads defined in the LS [7].

The material of the casing **shall** be complaint with section 6.2.2 of this document.

An interface handling feature is defined in [14].

The AV casing **shall** integrate the interface handling feature (lifting point), as defined in section 5.1 of [14], according to RHCP [13]. The AV **shall** have at least three lifting points of identical design to the crane twist-lock fittings. The horizontal triangle, made by the 3 lifting point centres **shall** enclose the AV centre of gravity.

Re-ionised "heat" loads (see LS [7]) can affect internal parts of the AV. The AV **shall** be equipped by a system that protect the parts exposed to these heat loads, this system is likely to be actively cooled – see section SPS 6.2.1.8

The internal cooling system of the AV **shall** comply to the draining strategy defined in the memorandum [15].

The AV casing **shall** also comply to the same draining strategy defined in the memorandum [15].

The AV casing **shall** be baked at a temperature greater than 180°C with a pressure of 0.01MPa (vacuum). Baking system of the AV **shall** be designed to perform up to 500 times in the life of ITER without any maintenance on the AV.

All other surfaces of the AV, exposed to the primary vacuum **shall** be baked at a temperature greater than 180°C. As well the NB port (up to the torus isolation valve) and the VVPSS piping (up to the rupture disk) that are out of the scope of the technical specification will be baked at a temperature greater than 180°C. Exceptions for lower-temperature baking of parts which are at or beyond the vessel ports boundary will be treated on a case-by-case basis. [PR427-R] of [16]

The VV and in-vessel components (as it is the case of the AV) **shall** be capable of being raised from room temperature or operating temperature to the baking temperature within 2 days. [PR430-R] [16]

Following baking, the VV and in-vessel components (as it is the case of the AV) **shall** be capable of being returned to their pre-pulse operating temperature within 24 hours. [PR431-R] of [16]

All systems (as it is the case of the AV) **shall** be designed to accommodate 500 baking cycles from the commissioning phase to the end of life. During D-T pulse operation, the estimated baking cycles are 40. [PR434-R] of [16]

6.2.1.7 Sub-system 4: Plate actuator

No specific requirement can be defined, at this stage, as this sub-system will be opened to any design proposal of the contractor.

Opening and closing times **shall** be typically less than 10 minutes for each operation

Code and standards and classification of this sub-system **shall** be defined according to section 6.1 and section 6.2.1.3.

This sub-system **shall** withstand the loads defined in LS [7].

6.2.1.8 Sub-System 5: Seal Protection System (SPS)

As introduced in the section above, a significant thermal loads called Re-ionisation can affect some internal parts of the AV. see LS[7]

The re-ionised power inside the AV has been defined regarding several potential scenario of the gas profile inside the NB ducts. The results of re-ionization inside the AV are defined in the LS [12].

The requirements on the sub-system5 will mainly depend of the proposal of the Sub-systems 1 and 2 developed by the contractor. The sealing system may not have to be protected, against re-ionisation heat loads, depending on the design proposal.

In this section, it is assumed that the design proposal of sub-system 1 and 2 leads to be affected by re-ionisation heat loads.

A design proposal of the SPS **shall** be developed to protect the AV internal parts potentially affected by these re-ionised loads. This design proposal is likely to be actively cooled; the cooling system **shall** be defined accordingly. The layout of the design proposal **shall** eliminate upstream facing edges and makes some allowance for beam divergence.

The SPS **shall also** provide protection for the seals and seats of the AV against dust transmitted (mainly during beam operations) when the AV is opened.
The current design of the SPS is a liner made of two rectangular static ducts and a sliding shutter, located inside the bore of the AV, without flexible hoses or pneumatic actuators on the downstream duct (the ITER VV side) as they are not allowed.

This liner protects the seals and seats and AV bore from divergent beam energy and re-ionised particles and, more importantly, shuts the gap between the two sides of the AV (when it is opened) preventing deposition and accumulation of dust on the seals and seats area located at the bottom of the AV.

The sliding shutters of the Seal Protection System shutters have to be capable of a linear movement of 125 mm. This in order to close fully the gap when the valve is opened. As well, they **shall** also open to a position just beyond the end stop contact faces of the seals to allow the necessary clearance when the valve plate is being closed.
The linear movement of each shutter is driven by means of two bi-directional pneumatic actuators located inside the main cylindrical conduit of the AV.
The pneumatic actuators shall be compatible with the vacuum environment and the vacuum requirements [6].

The moveable shutters slide inside the fixed ducts and have internal dimensions equal to those specified for the beam envelope: 1,457 mm high by 597 mm wide with a 30 mm corner radius.

The AV SPS can be served by the NBI PHTS (high resistivity) cooling circuit. It has the following properties:

- Operational Inlet pressure 2.2MPa (+/-0.2MPa) => 2.4 MPa (absolute)

- Max Operational inlet temperature. 38°C
-Max outlet temp. <90°C
-resistivity >5 MΩ.cm

In case of maintenance, on the NB line, the SPS **shall** be designed to be dried with hot gas; the pressure of this hot gas has been designed to not have an impact on the PED classification of the SPS - see LS [7]

6.2.1.9 Sub-system 6: Locking system

In order to prevent accidental openings during maintenance operation in the neutral beam injector, a locking system **shall** be implemented. This locking system is defined as PIC-SIC 1 component.
As SIC1 component, two position indicators for AV plate in fully opened position and two position indicators for AV plate in fully closed position **shall** be implemented to provide a redundant signal to state the position of the locking rod of the valve plate.

The current design is based on locking being achieved with a normally closed (spring closed) pneumatic actuator which opens with 6bar (g) air pressure once the pendulum arm is closed position confirmed by its position sensor.
A stainless steel rod is guided through bushings, ridged enough to guarantee it’s function even when the pendulum arm is accidently opened. Two position indicators for open and two position indicators for closed position provide a redundant system to state the position of the locking rod.
The contractor is free to propose any design proposal of the locking system compliant with the requirements of this technical specification and the SIC-1 classification of the locking system. 6.2.1.3

6.2.1.10 Sub-system 7: I&C components

Thermocouples, electrical heaters, position indicators are likely to be used on the AV design to comply with the different requirements of the sub-systems defined in the document.

Thermocouples placed at the inlet and at the outlet of the DD liner cooling pipe, shall allow calorimetry.

As there is no possible maintenance once the AV is installed, the redundancy of each heating element **shall** be implemented if used on the design of the contractor, for the baking requirements.

In case of failure on one heating element, the second one can be connected in the electrical room and the complete assembly can continue to work normally.

Cable Assemblies and Cables shall be made only of the materials (to the standard relevant for the initial form of the material), listed in table 3.

Component	Material
For the cable sheath, one of the following grades of Stainless Steel:	• 316L (UNS S31603). Impurities shall not exceed any of the following limits: 0.050 weight % Cobalt; 0.010 weight % Niobium and 0.010 weight % Tantalum. • X2CrNiMo17-12-2. Impurities shall not exceed any of the following limits: 0.050 weight % Cobalt; 0.010 weight % Niobium and 0.010 weight % Tantalum.
Cable insulation materials	• Alumina with purity ≥ 99.55% for Cable type # A1, B1, A2, B2, A5, B5, A6, B6, A7 and B7 • Silica with purity ≥ 96% for Cable type # A3, B3 and A4
Cable cores of Cable type A6 and B6	• Nicrosil and Nisil. Cable core(s) shall contain no coating.
For the Cable cores of all other Cables, one of the following options shall be used:	• Oxygen Free Copper (Cu-OF, CW008A, UNS C10200, JIS C1020). Cable core(s) shall contain no coating. • Oxygen Free Electronic Copper (Cu-OFE, CW009A, UNS C10100, JIS C1011). Cable core(s) shall contain no coating.
Options for the Extensions	• CuNi2Si (WNr. CW111C, UNS C64700) • Alumina dispersion strengthened copper alloy (UNS C15715)
For the construction of the terminations, the following materials shall be used	• 316L (UNS S31603) or X2CrNiMo17-12-2 No 14404. Impurities shall not exceed any of the following limits: 0.050 weight % Cobalt; 0.010 weight % Niobium and 0.010 weight % Tantalum. For the termination sleeves, only the Impurities shall not exceed any of the following limits: 1.00 weight % Cobalt; 0.20 weight % Niobium and 0.20 weight % Tantalum. • Nicrosil and Nisil. Cable core(s) shall contain no coating. • Oxygen Free Copper (Cu-OF, CW008A, UNS C10200, JIS C1020). Cable core(s) shall contain no coating. • Oxygen Free Electronic Copper (Cu-OFE, CW009A, UNS C10100, JIS C1011). Cable core(s) shall contain no coating. • Nickel Iron Alloy 42 (NILO 42 / FeNi 42) (UNS K94100, WNr 1.3917) for pins, pin reinforcing tubes and termination bodies only. • Kovar (UNS K94610) • DP1 (Dilver P1) • Alumina (≥ 92% purity) • Nickel 200/201 (UNS N02200 / N02201) for the pins of the special termination of Cable A4 only • CuNi2Si (WNr. CW111C, UNS C64700) • Alumina dispersion strengthened copper alloy (UNS C15715) • Gold, at ASTM B488 Type II Code C Class 1.27 (or equivalent); for the pins of the special termination of Cable A4 only • Threebond 3732 inorganic adhesive (see REQ-55-NEV0-MIC-099) • Resbond 908 based in alumina.

Component	Material
Braze alloys used in the Cable terminations	BAg-8 / Ag-Cu 72-28 (JIS Z3261, UNS P07720), Ag 272 (EN 17672); Nicuman 23; Nicuman 37; STEMET 1101; STEMET 1108. Additionally, and only for the A6 cable: Pure Copper Cu OFE (CuC2)
For interlayer of copper coating	If an interlayer for the copper coating is needed, the material to be used shall be Nickel

Table 3 – MIC material

The supplier **shall** design the MICs in accordance with the requirements of this technical specification.

The MICs **shall** be Mineral Insulated type.

The MICs **shall** be compliant with the following conditions of use:

- Normal operating pressure: Vacuum
- Vacuum Quality class: VQC1-B
- Normal operating temperature: 550°C (when baking in operation)
- Maximum temperature: 650°C

The MICs **shall** be compliant with the ITER Vacuum Handbook requirements applicable to their VQC classification.

6.2.1.11 Sub-system 8: Trolley support of the AV

The AV is supported by the AV trolley support. IO has already work on a draft solution of this trolley support in the frame of the design development of the neighbouring component VVPSS Box and its trolley. The two NB FEC, VVPSS Box and AV are supported by two trolleys which are linked regarding the assembly and maintenance operations.

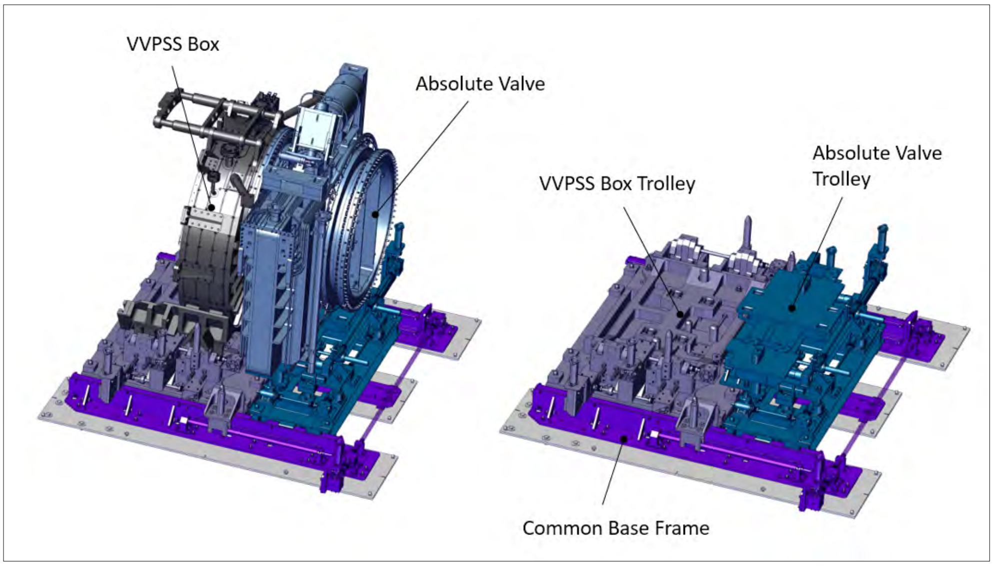


Figure 8: Trolleys of the NB FEC

A common Base frame supports the two trolley. The Base frame and the VVPSS box trolley is not in the scope of the feasibility study. Only the Absolute Valve Trolley is part of the scope of the contractor.

IO will provide all information of the draft design of the AV trolley already started. The contractor **shall** continue the development on the AV trolley taking into account the AV interfaces that he will design.

The AV trolley **shall** be designed in accordance with the Trolley Load Specification [20].

The AV Trolley **shall** be designed in accordance with the code and standards and classification see section 6.1 and 6.2.1.3

The AV Trolley **shall** be developed taking into account the evolution of the AV by the contractor.

The valve feet **shall** sit on the trolley. On lowering the valve into position, the catcher plates **shall** ensure rough alignment of the valve.

The valve is also supported from beneath by means of a trolley which bears its weight, but with sufficient compliance to accommodate thermal expansion of the valve without transferring significant loads across the flange interfaces.

The trolley provides no constraint in the axial or transverse directions. The use of a similar trolley to support the VVPSS box and drift duct assembly ensures that there is no axial or transverse constraint on any of the front end components.

The valve feet shown in Figure 7 sit on the trolley shown in Figure 8. On lowering the valve into position the catcher plates ensure rough alignment of the valve, sufficient for the precise alignment to be fixed as the slot mates with the long dowel and then the slot with the short dowel. No fastenings are currently shown, but it is planned to use captive bolts with long drive bars that can be driven by the manipulator from the top of the valve.

6.2.1.12 Compressed air (for information)

Compressed air, or other ITER specified gas is required to drive various actuators and mechanisms on the valve.

The Absolute Valve only incorporates air lines and an interface block to connect them to the supply system. It is assumed that all the control valves and systems will be located in a cubicle outside of the NB cell in a location that is easily accessible for maintenance.

6.2.1.13 Electrical power (for information)

Standard 240 V AC will be available and supplied to the valve via the interface defined.

6.2.1.14 Control & instrumentation (for information)

Since the instrumentation set for the valve has not yet been defined, the cabling has not been routed yet and no interface is currently included. The I&C connections should either be installed on the interface block or use a separate connector. This work **shall** be developed during the study.

6.2.1.15 Electromagnetic (for information)

Subassemblies of this component whose function may be unacceptably affected by electromagnetic fields at their installation location shall be shielded so that their performances are not unacceptably affected by the fields.

The most important fluxes generated by the tokamak will induce loop voltages in the horizontal planes and not in the vertical (radial) ones. This **shall** be taken into account when tracing cable routes to reduce loop voltages and when designing insulation layout to reduce eddy currents.

6.2.2 Material, welding and fabrication requirements

The use of Halogenated materials, sulphur and phosphorus for the AV that is Tritium Classified **shall** be avoided. Indeed, these materials lead to potential for oxidation catalyst poisoning and to metallic corrosion due to acid formation.

All the materials for use in vacuum **shall** respect the requirements from chapter 5 of the Vacuum Handbook [6] and document [36].

The AV Stainless Steel (SS) **shall** be the X2CrNiMo17-12-2 controlled nitrogen (the X2CrNiMo17-12-2 controlled nitrogen is described in the RCC-MR Code Section A3.1S)

The chemical composition determined by ladle and product analyses of X2CrNiMo17-12-2 controlled nitrogen shall comply with the requirements given in Table below: Chemical composition of X2CrNiMo17-12-2 controlled nitrogen .

Chemical composition, X2CrNiMo17-12-2 controlled nitrogen	**Content in Wt. %**
Elements	*Range or Max*
Fe	balance
C	0.030
Mn	1.60 - 2.00
Si	0.50
P	0.030
S	0.015
Cr	17.00 - 18.00
Ni	12.00 – 12.50
Mo	2.30 – 2.70
N	0.060-0.080
Cu	1.00
B	0.0020
Additional ITER specific requirements:	
Co	0.05
Nb	0.01

Ta	0.01
Ti	0.10

All welds of the casing which provides the first confinement barrier **shall** be identified in the following IO Template (see Appendix 01) .

6.2.3 Operating requirements

This component **shall** be designed to cope with real-time power control of the beam which is designed to vary by +25%/-50%, whilst keeping below the maximum of 16.7MW to ITER, with a maximum frequency of 7 Hz.

The design of this component **shall** not preclude pulse lengths of up to 3,600s at all beam powers and energies.

The design of this component **shall** provide a thermal fatigue life consistent with the total number of pulses/pulse duration (50 000) foreseen by ITER operation, and by the commissioning and testing of the system as shown below:

It can also be assumed do not adversely affect fatigue life of this component.

The design life of this component **shall** be 20 years.

The Absolute Valve **shall** operate reliably for absolute sealing for 100 open/close operations.

For low conductance operation, the capability of the AV **shall** assume 2400 cycles during the life of ITER.

This component **shall** be compatible with H^0 and D^0 beams.

- The different states in which the AV will operate during its life are listed below:
    - State 1: transport & handling

The AV will have to be transported on ITER site. No additional load apart should be applied to the AV. The valve **shall** be equipped with some mechanical locks that stops it moving during handling.

- State 2: leak tests

After manufacturing and welding, the AV leak rate will be helium leak tested on the manufacturing plant following the VHB [6] – Appendix 12 [17].

- State 3: **during NB injection pulse**

This state describes normal operation when the beam is launched in the plasma. The Absolute Valve (casing) becomes Vacuum boundary. **The Absolute Valve shall be opened**. As the injector works and Plasma launched, the risk of re-ionization is high. Re-ionised power could appear on the internal side surfaces of the AV.

Re-ionisation: *The re-ionised power inside the AV has been defined regarding several potential scenario of the gas profile inside the NB ducts. A liner (SPS) actively cooled shall withstand the heating loads when the Absolute Valve is opened.*

- State 4: **between NB injection pulse**

This state describes the period between pulses when the system is waiting for the next NB injection pulse. **The Absolute Valve shall be opened**.

- State 5: **Baking operation**

Depending the technical proposal of the contractor, the AV can be baked in open or closed position. There is no ITER requirement regarding the state of the AV during Baking even if it was recommended to bake the AV in closed position with the current design.

The AV **shall** be baked at a temperature greater than 180°C with a pressure of 0.01MPa (vacuum). Baking may be performed up to 500 times in the life of ITER.

All other surfaces exposed to the primary vacuum **shall** be baked at a temperature greater than 180°C, including the NB port (up to the torus isolation valve) and the VVPSS piping (up to the rupture disk).

All systems shall be designed to accommodate 500 baking cycles from the commissioning phase to the end of life. During D-T pulse operation, the estimated baking cycles are 40.

NB group would suggest as guideline: 200^{o}C ± 20^{o}C for the baking temperature of the AV.

- State 6: Incident and Accident Events

Accident and incident events are pressure loads which are described in the Load Specification document [7]

Upset operating conditions may result in pressure differentials across the gate in excess of 0.1 MPa, up to a maximum design value of 0.2 MPa. The AV gate shall withstand these events without any significant permanent deformations. This is defined in the Load Specification document [7]

During normal operation the pressure in the NB cell is 0.1MPa absolute. During maintenance of a NB internal component the valve will be exposed to the same pressure as in the NB cell. In this case, the pressure in the VV can be between 0 and 0.1 MPa

Tokamak load case of category 4 leads to a pressure in the VV of 0.2 MPa which results into a pressure difference across the closed AV gate of 0.1 MPa.

During RH operation for the potential removal of the AV, the AV **shall** be lifted by the NB cell RH crane.

The NB cell RH crane is limited to movement along the rails in the cell ceiling. and it is a requirement that the centre of gravity of each component to be lifted **shall** be within a rectangular envelope related to four twist-lock fittings built into the RH lifting adaptor (see figure 9).

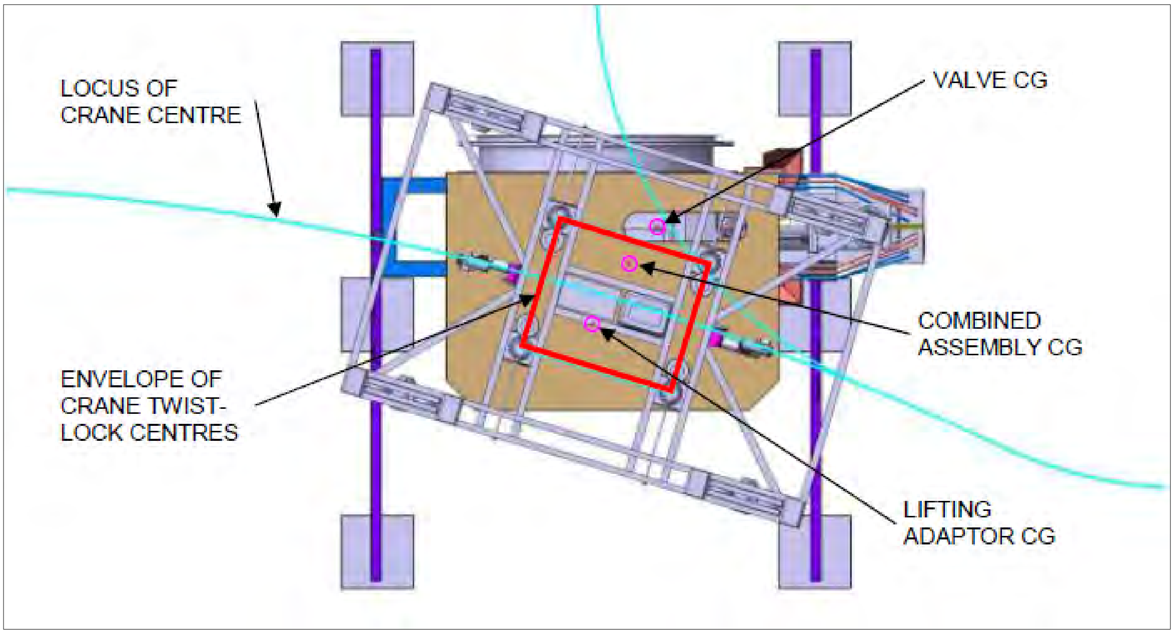


Figure 9: Lifting interfaces

Figure 9 above shows the RH crane in the closest available lifting position to the AV centre of gravity position above the valve. Since the four twist-locks lifting points on the crane do not line up with features on the valve, a lifting adaptor (not in the scope of this technical specification) to make the connection between the valve and the crane is needed. The adaptor has a counterweight (movable system) of sufficient mass and offset to ensure that the combined centre of gravity lies within the envelope of the four lifting points. The combined mass of both the valve and the adaptor will be less than 10 tonnes.

The current design of the AV has three lifting points of identical design to the crane twist-lock fittings (Figure 10) implemented on the casing (Sub-system 3 – see 6.2.1.6). The triangle between the twist-lock centres encloses the valve centre of gravity. The slots in the fitting are differently oriented to minimise movement of the AV when suspended.

In the frame of the Sub-system 3 task (section 6.2.1.6), the contractor is free to propose a new solution of casing taking into account the lifting points requirements defined in this section and section 6.2.1.6.

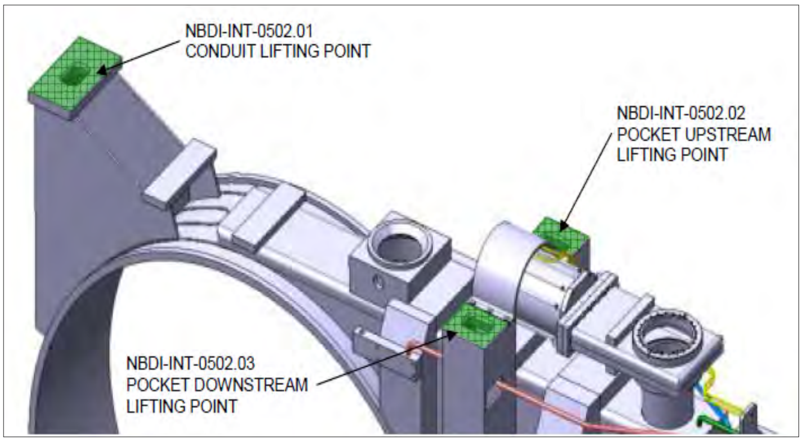


Figure 10: Lifting points of the AV (current design)

Figure 11 below shows the lifting adaptor customised according to the current AV design, in place prior to lifting and a close-up of the adaptor showing the twist-lock fittings.

The most recent studies on the crane route through the NB cell indicate that the maximum height available for components **shall** be 3,000 mm.

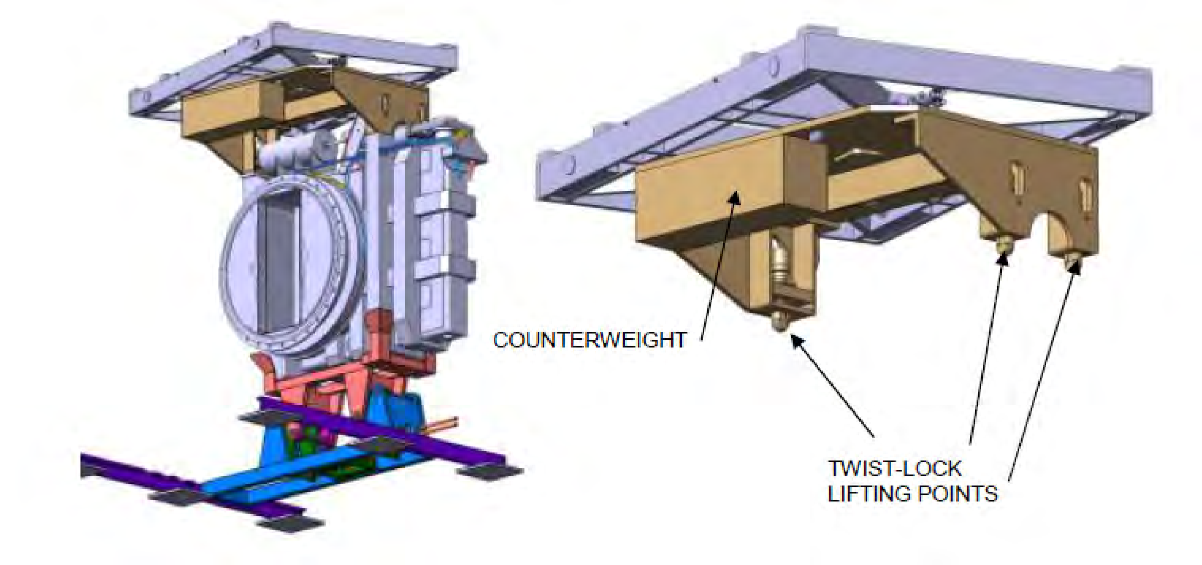


Figure 11: Lifting adaptor for RH crane and Absolute Valve.

6.3 Assembly

The AV **shall** be designed as a stand-alone component and will be manufactured, assembled and tested off-site.

It may, therefore, be installed as a module with no further setup required. It is envisaged that the valve **shall** have a transport locking mechanism to prevent movement of the plate while the actuators are not active. This may require some minor intervention to deactivate or remove the mechanism. Ideally the interfaces for first assembly can be the same than for RH lifting in case of maintenance.

6.4 Maintenance on the AV

As an RH class 3 component, it is a requirement that the valve continue to function adequately throughout the duration of the ITER experimental programme **– see section 6.2.1.3**

As such, no maintenance operations on the AV **shall** be foreseen. In the event of a failure of the valve or degradation of performance to unacceptable levels, the valve would need to be removed and replaced by a new one. Refurbishment of the valve is not expected.

Development of the remote handling process and tooling is on-going.

Details of the removal and reinstallation processes can be found in the Remote Handling Compatibility Report for the AV [18][19].

6.5 Performance requirements

As already required in section 6.2.1.1, the AV design will have to be compliant with all loads incident and accident events defined in the Load Specification [7]

6.6 Interface requirements

The Interface requirements are defined in the different sub-systems defined in section 6.2.
The Absolute Valve has three main physical interfaces:

1- The VVPSS box: flanges bolted with Absolute Valve; the first confinement barrier is ensured by a double metallic seal.

2- The Fast shutter: flanges bolted with Absolute Valve; the first confinement barrier is ensured by a double metallic seal.

3- The NB cell floor: the Absolute Valve is supported by the AV support trolley (see section 6.2.1.11) on the NB cell floor.

The Absolute Valve has different functional interfaces with the following systems (apart from PBS 53):

- **Vacuum** (PBS 31): connection to AV interspace, for pumping,
- **Remote handling** (PBS 23): interfaces for maintenance.
- **Cooling** (PBS 26): NBI PHTS cooling circuit is used for cooling the plate and of the seal protection system
- **Building** (PBS 62): AV trolley support is sliding on rails attached to the NB cell floor.
- **Pneumatics**: Plate, Seal and Seal Protection System (SPS) actuators may require compressed air supplies.
- **CODAC** (PBS 45): signals used by CODAC to determine the valve states.
- **Electrical**: 240 VAC power required for Seal Actuator Temperature control system.

The AV **shall** comply with the requirements defined in the Interface documents listed below:

- ✓ IS-53-31-009-HNB-Absolute Valve of the HNB injectors [5]
- ✓ IS-26.CC-53-002 Interface Sheet Component Cooling Water system (PBS26.CC.2B)-Neutral Beam H&CD system (PBS53) [43]
- ✓ 23-53 - Remote Handling System-Neutral Beam H&CD System [Ref?]
- ✓ 53-62 - Neutral Beam H&CD System-Reinforced Concrete Buildings [Ref ?]

6.7 Manufacturing Requirements

The manufacturing feasibility **shall** be clearly demonstrated. As first confinement barrier, the casing of the AV **shall** be developed and manufactured in accordance of the code and standards defined in the section 6. This component shall be designed to RCC-MR class 2.

In addition to the nuclear manufacturing code to apply, one of the main challenges will be to ensure the vacuum Tightness of the gate valve with metallic seals.
For the manufacturing of the in-vessel components (in the case of the AV, this correspond to the internal system which are not part of the first confinement barrier) generally there are two types of technical procedures:

1) Manufacturing procedures for parts or components which are addressed by conventional Codes and directive requirements. These procedures are typically related to conventional welding, brazing joining, and NDT. The related specifications **shall** be prescribed in accordance with Code or Directive or Order requirements. To be compatible with ESP and ESPN requirements, the recommended manufacturing Code is EN 13445.

2) Manufacturing procedures for parts or components which are not addressed by conventional Code requirements (e.g. beryllium/Cu joints for first wall, non-metallic material joining, etc.).

For the this type of manufacturing procedures ITER specific Technical Specification Documents **shall** be prepared or they will be defined in the Procurement technical specification Documents. The justifications shall be supported by R&D.

6.8 I&C Requirements

Since the instrumentation set for the valve has not yet been defined, the cabling has not been routed yet and no interface is currently included. The I&C connections should either be installed on the interface block or use a separate connector. This work **shall** be developed during the study.

These services **shall** be accessible by the RH manipulator so that it is able to deliver and use the appropriate tooling to make and break the connections.

6.9 General analysis Requirements for the AV

The contractor **shall** perform, for what concern the conceptual design, the full analysis to comply to the loads defined in the ABSOLUTE VALVE LS[7] and Trolley LS[20].

The contractor **shall** provide, for what concern the conceptual design, theSupporting documentations and calculation reports (Finite Element Analysis, etc.) following the defined Codes & Standards (code RCCMR-2007, boiler and pressure vessel code, etc.)

The contractor **shall** use the instructions and guidelines for structural analysis and structural analysis reports given in the table 5 below:

The applicable documents for the analysis are indicated in table 4 below:

Applicable document		ref
Instructions for Structural Analyses	Instructions for Structural Analyses	22
	Procedure for Analyses and Calculations	23
	Template for structural analysis reports	24
	Software Qualification	25
Instructions for Seismic Analyses	Instructions for Seismic Analyses	21
	Procedure for Analyses and Calculations	23
	Template for seismic analysis reports	27
	Software Qualification Policy	25
Instructions for CFD Analyses	Instructions for Computational Fluid Dynamics Analyses	28
	Procedure for Analyses and Calculations	23
	Template for CFD analysis reports	29
	Software Qualification Policy	25

Table 4 – Applicable document for analysis.

Since the storage of every analysis on IO's analysis database is a required step, the Applicable Document [30] shall be fulfilled. Examples of implementation are given in a "How To" referenced by this document [30] to remove any ambiguity/doubt in interpretation.

6.10 Summary of the key AV requirements

Valve overall dimensions (maximum, about beam axis)	Horizontal width ~3250 mm Height ~3000 mm Length (along beam axis from flange to flange) ~1250 mm All numbers including piping
Weight conditions	< 10 tons
Duct dimension (Major axis vertical)	Vertical 1457 mm Width 597 mm
Operational conditions	Valve in open position during ITER operational periods, typically many weeks. Valve closed for planned maintenance of the caesium oven. For this planned maintenance it is expected to close the AV ones per year.
Operation of the valve	The valve will be operated and controlled by the vacuum systems. The valve position signal (open / closed) shall be provided. It will be managed by the central vacuum control system. Signal for temperatures of the valve and for the shield (SPS) temperatures shall be provided.
Opening and closing times	Typically, 10 minutes for each operation.
Type of seal and seat	Metallic with metal to metal interface
Maximum leak rate for absolute sealing across absolute valve	Maximum leak rate $\leq 1\cdot10^{-8}$ $Pa\cdot m^3/s$ for 100 cycles. (at a pressure difference of 1 atmosphere)
Maximum single leak rate for absolute sealing across one seal	$\leq 1\cdot10^{-5}$ $Pa\cdot m^3/s$ (at a pressure difference of 1 atmosphere) and a pumped interspace to 100 Pa

Maximum allowable leak rate of the casing of the AV	1E-10 Pa.m^3/s air equivalent from exterior atmosphere to internal vacuum.
Valve interspace pressure	To be vacuum pumped to <100 Pa so that the overall leak rate will be met with the single leak rates for 100 cycles.
Maximum leak rate for low conductance operation	For low conductance operation a maximum leak rate of 10^{-2} Pam^3/s for about 3000 cycles is required.
Valve interspace surface temperature	Operation: <100ºC
Valve interspace surface area	To be defined during finalization of design
Valve interspace volume	To be defined during finalization of design
Baking temperature	Casing to 200ºC
System replacement period	**≥ 20** years as it is RH class 3
Normal operating temperature	Seal Protection System water cooled with 38 ºC inlet temperature and a ΔT of 50 ºC
Pressure requirements	
Identified operational scenarios call for the valve to sustain a bi-directional maximum pressure differential of 2 bar across the valve, acting as an absolute seal between the ITER VV and the Neutral Beam Vessel.	
Max. design pressure external	0.16 MPa
Max. design pressure internal	0.2 MPa
Radiation	
At the absolute valve	Typically, 10 Sv/h during operation but may be reduced due to shielding from ITER vacuum vessel and blanket
Magnetic field	B = 75 mT
Materials	

Overall system	All components to be metallic. Typically, stainless steel AISI 316LN.
Heat loads	
Radiation from the plasma (to the gate when AV closed)	~500 W/m^2, due to Bremsstrahlung, synchrotron and impurity radiation
Nuclear heating	0.008 W/cm^3

Table 5 – Summary of the key AV requirements.

7 Quality Assurance (QA) requirements

The organisation conducting these activities should have an ITER approved QA Program or an ISO 9001 accredited quality system.

The general requirements are detailed in ITER Procurement Quality Requirements (ITER_D_22MFG4).

Prior to commencement of the task, a Quality Plan must be submitted for IO approval giving evidence of the above and describing the organisation for this task; the skill of workers involved in the study; any anticipated sub-contractors; and giving details of who will be the independent checker of the activities (see Procurement Requirements for Producing a Quality Plan (ITER_D_22MFMW)).

Documentation developed as the result of this task shall be retained by the performer of the task (in this case the contractor) for a minimum of 5 years and then may be discarded at the discretion of the IO. The use of computer software to perform a safety basis task activity such as analysis and/or modelling, etc. shall be reviewed and approved by the IO prior to its use, in accordance with Quality Assurance for ITER Safety Codes (ITER_D_258LKL).

8 CAD Design Requirements (if applicable)

For the contracts where CAD design tasks are involved, the following shall apply:

The Supplier shall provide a Design Plan to be approved by the IO. Such plan shall identify all design activities and design deliverables to be provided by the Contractor as part of the contract.

The Supplier shall ensure that all designs, CAD data and drawings delivered to IO comply with the Procedure for the Usage of the ITER CAD Manual (2F6FTX), and with the Procedure for the Management of CAD Work & CAD Data (Models and Drawings 2DWU2M).

The reference scheme is for the Supplier to work in a fully synchronous manner on the ITER CAD platform (see detailed information about synchronous collaboration in the ITER GNJX6A - Specification for CAD data production in ITER Contracts.). This implies the usage of the CAD software versions as indicated in CAD Manual 07 - CAD Fact Sheet (249WUL) and the connection to one of the ITER project CAD data-bases. Any deviation against this requirement shall be defined in a Design Collaboration Implementation Form (DCIF) prepared and approved by DO and included in the call-for-tender package. Any cost or labour resulting from a deviation or non-conformance of the Supplier with regards to the CAD collaboration requirement shall be incurred by the Supplier.

9 Safety requirements

The **P**rotection **I**mportant **A**ctivities are identified by the Nuclear Operator. The list of the Protection Important Activities is based on the chapter 10 of the RPrS [Preliminary Safety Report (RPrS) [31] and the application of the INB Order which applies to all the lifecycle of a nuclear facility [34].

The PIAs for the NB Injector are defined in the Surveillance plan [33]. During design phases, the safety demonstration is considered as PIA; the design study of the Absolute Valve which are first confinement barrier is a safety demonstration.

IO will manage this activity as follow:

PIA	Defined requirement	External interveners	Nature of the surveillance	Frequency of the surveillance	Actor of the surveillance	Formalization of the surveillance	Records management	Record location
Safety Demonstration related to safety demonstration	Compliance with the defined requirements for each PIC [(LAMFG2) Application of the procedure (LAMFG2)	All	Review of the document	For each document	TRO	Review in IDM	Standard IO rule (22K5JQ)	IDM folder 2N78DT

The Contractor shall provide a Quality plan at the kick off meeting. This QP shall remind the safety function of the Absolute Valve.

The Absolute Valve as a PIC must ensure the following nuclear safety function:

- Confinement: the Absolute Valve belongs to the First confinement barrier
- Minimization of radiological exposure: the used Material that will be activated shall have a low concentration of Cobalt, Niobium and Tantalum.

Absolute Valve items classified SIC are also classified PIC. The development of the Absolute Valve shall comply with [35]- Provisions for Implementation of the Generic Safety Requirements by the External Interveners, that defines generic safety requirements to be implemented by all external actors in order to satisfy the requirements of the Order dated 7 February 2012 relating to the general technical regulations applicable to INB [34].

The Suppliers and Subcontractors must be informed that:

- ITER is a nuclear facility identified in France by the number-INB-174;
- The Order 7th February 2012 title I and II replace Order 10th August 1984 since the 1st July 2013;

- The Order 7th February 2012 applies to all the components important for the protection (PIC) and the activities important for the protection (PIA).
- The compliance with the INB-order must be demonstrated in the chain of in the chain of contractors and subcontractors.
- In application of article II.2.5.4 of the Order 7th February 2012, contracted activities for supervision purposes are also subject to a supervision done by the Nuclear Operator (IO).

A specific management system has to be implemented by any Supplier and Subcontractor working on protection important activities, on the basis of activities defined and executed by the Supplier and Subcontractor.

The contractor shall refer mainly to the document [35] which is a declination of the French order 2012.

For the contract which is a study, the supplier shall comply with the following points:

- To get validated input data
- To use a validated and qualified code in the range of use
- To ask a 3rd person to check the analyses (IO Peer reviewer).

This corresponds to comply with R13 and R28, an R29 of SBSTBM [35].

Regarding the Nuclear safety function << confinement>>, the main PIAs for the Absolute Valve are the following:

- All Analysis based on the LS [7] ensuring the integrity of the confinement of the Absolute Valve
- All Activities linked to the Welding data Book and the associated controls.

Regarding the Nuclear safety function << minimization of radiological exposure>>, the main PIAs for the Absolute Valve are the following:

- The chemical composition of the material
- Material certificate deliverables

For the Nuclear Safety, it is important to remind the importance to refer to the following applicable documents:

- Provisions for Implementation of the Generic Safety Requirements by the External Interveners [35]
- ITER Policy on Safety, Security and Environment Protection Management)
- Overall Surveillance Plan of External Interveners Chain for Protection Important Components, Structures and Systems and Protection Important Activities [33]
- Guideline for Identification of the Protection Important Activities (PIA) [44]
- Safety Important Functions and Components Classification Criteria and Methodology [8]

10 Location for Scope of Work Execution

The Contractor can perform the work at their own premises.

11 Estimated duration

The maximum expected duration from the contract signature to the supply of the scope of work is 10 months.

12 List of deliverables

The Supplier **shall** provide IO with the documents and data required in the application of this technical specification and any other requirements derived from the application of the contract.
All deliverables (technical documents, drawings and CAD models, etc.) detailed here after produced **shall** be made available to the IO upon request. The transfer of documentation may be for information only for work in progress.

12.1 Deliverables

12.1.1 QP = Quality Plan of the contract

The Project Manager of the contractor **shall** issue the Quality Plan of the Contract which will be submitted to IO for approval.
A first draft will be circulated to IO one month after the signature of the Contract. The draft Quality Plan will be discussed in the kick-off meeting and accordingly modified in a new and agreed version.
The Project Plan summarizes the tasks content by means of a detailed work breakdown structure, a time plan scheduling how the activities will be carried out, and details of the personnel resources to be employed in each subtask.

12.1.2 Deliverables of the Tasks

The conceptual mechanical design (CMD) deliverables are constituted of:

- Conceptual Mechanical Design Model limited to 3D models. Integration in the NB cell environment, and does not extend to the level of details typically found in 2-D printed drawings.
- Supporting documentations and preliminary calculation,
- Technical Risks assessments.
- No detailed calculation report shall be required at this stage; preliminary calculations shall support the design report and the demonstration of the feasibility or showstopper if any. The acceptance of any showstopper identified by the contractor shall depend of the four criteria described below:
  - ✓ Infeasibility of engineering system using the states of the art
  - ✓ Infeasibility of integration in the environment given by IO
  - ✓ Infeasibility to provide a solution which can meet the IO requirements defined in this Technical specification
  - ✓ Mechanical limit of the material

❖ In the scope of the supported documentation, the contractor **shall** deliver the System Design Description (**SDD**):

The System Design Description shall be sufficient to give confidence in the feasibility of the proposed solution (technical aspects but cost and schedule too). Alternate solutions can be defined. In such case, Pros & Cons shall be identified in order to prepare the selection to be finalized at the end of CD phase. This could include proposals for additional studies in order to allow relevant selection.

SDD **shall** describe, at system level, at least one design solution which meets the requirements with an acceptable level of risk.

SDD **shall** list and describe all assumptions made or issues raised during the CD phase. They could concern:

- Input data, Requirements
- Design itself: Design choice which has to be confirmed by review, study to perform, etc.
- Interface: Interface data not available when needed by design activity

For each solution proposed, the SDD **shall** describe with more details on finalized solution the following:

- System Overall Architecture identifying the main components of the System and the main links between these components (with support of PFDs)
- The functions allocated (with support of Functional Analysis)
- The main technical characteristics required to justify the feasibility
- In case of systems which behaviour highly depends on the state of the plant (e.g. Cooling Water System-CWS or Steady State Electrical Network-SSEN), the main performances in all operation states (with a preliminary version of the System Detailed Performances Definition).

❖ In the scope of the supported documentation, the contractor **shall** deliver the Process Flow Diagram (**PFD**):

PFD shall identify on main content sheet:

- Main Components (all the necessary components to be able to clearly understand the process),
- Main/key features of the components,
- Exchanges between systems/sub-systems (input/outputs/flow direction),
- Whenever possible room location (GBS) of components

Comments:

- *"Main Components" are components needed to fulfil system's main functions or main requirements (space allocations, safety) or to be able to clearly understand the process*
- *Components for constraint or secondary function are not identified at this stage*

❖ In the scope of the supported documentation, the contractor **shall** deliver the Detailed Model-(**DM**):

Concept of the geometry to fulfil functional needs

- Main interfaces are identified
- Major Dimensions
- Define the space occupied by the component/system

3D CAD models reflecting the design maturity of the CDR with an assembly 2D drawing of the Absolute valve (HNB1 & HNB2) shall demonstrate the compliance of the IO requirements defined in this document. The 3D models of the AV shall be consistent with the NB cell environment and in accordance with the interface of the neighbouring components.

- The appropriate gaps, tolerances and RH access shall be defined at this stage; all the interfaces of the component shall be frozen.
- The overall concept of each subtask shall be clearly defined (functions fulfilled, dimensions, interfaces)

The Detailed Models **shall** allow first calculations and simulations (e.g. Assembly, RH)

In the scope of the supported documentation, the contractor **shall** deliver the Design Justification Plan (DJP):

The Design Justification Plan (also called as Verification & Validation Plan) describes the strategy to provide evidence of the fulfilment of Design Input Requirements in the Design.

The V&V (Verification and Validation) Plan defines, for each system requirement (or class of requirement) defined the Design Input Requirements (i.e. PR, SRD, Sub-SRD etc…) , the way to conduct the justification, verification and validation of the design at any gates of the system development:

- Test (on mock-up, prototype, at factory, etc.)
- Alternate calculation
- Simulation
- Analysis of Design by Expert (based on REX, R&D or similarity)
- Inspection

- In the scope of the supported documentation, the contractor **shall** deliver the Design Compliance Matrix (**DCM or VCM**):

At CD stage, the DCM shall:

- Roughly define why the requirements will be achieved by the solution(s) proposed. At this stage this justification can be engineer advice
- Identify the requirements that may not be achievable (and therefore propose SRD update). In that case DCM shall refer to the analysis of impacts of the proposed modification

- In the scope of the supported documentation, the contractor **shall** deliver the Functional Analysis Report (**FAR**):

All functions carried out by the System are identified:

- Functional decomposition breaks the System down in a hierarchical decomposition
- In every normal operating state of the plant/System:
  - ✓ Each function behaviour is exhaustively described
  - ✓ Expected objectives/performances defined in a clear, unambiguous way
- In some incident and accident state of the plant/System to be chosen in the LS [7]

- In the scope of the supported documentation, the contractor **shall** deliver Engineering Analysis and Calculation Report:

At each design stage, Analyses and Calculations are carried out. It is worth highlighting that a plan for progressive refinement of studies (with clearly planned documentation) allows updating of reports and avoids overlaps between documentation.

Analyses **shall** be provided to justify the design concept. It is considered sufficient to comply with main driving requirements at the end of Conceptual design phase.

- In the scope of the supported documentation, the contractor **shall** deliver REX and Research and Development (R&D) Report:

The designer identifies what previous experience can be useful for the AV design:

- Reports from previous operational experience are collected and listed to support system design justification.
- ROX data becomes input data for the design itself and supports choices for design and system design justification
- R&D results, from completed studies, used to justify the design and the performances

Here below a minimum list of documents, but not limited to, that are required within the expected timing:

UID	Deliverables	Intermediate deliverables	Expected Timing (T0+x) *
D-AV-00	Quality Plan (**QP**)	100%	T0+1 month
D-AV-01	System Design Description (**SDD**)	50 % 100%	T0+ 5 months T0+12 months
D-AV-02	Process Flow Diagram (**PFD**)	70% 100%	T0+ 4 months T0+ 10 months
D-AV-03	Detailed Model-(**DM**)	30% 50% 100%	T0+ 3 months T0+ 5 months T0+ 10 months
D-AV-04	Design Justification Plan (**DJP**)	50 % 100%	T0+ 5 months T0+12 months
D-AV-05	Design Compliance Matrix (**DCM or VCM**)	50 % 100%	T0+ 5 months T0+12 months
D-AV-06	Functional Analysis Report (**FAR**)	30% 50% 100%	T0+ 3 months T0+ 5 months T0+ 10 months
D-AV-07	**ROX** and **Research and Development** Report	100%	T0+12 months

(*) T0 = Commencement Date of the contract; X in months.

13 Specific General Management requirements

General Management Specification for Service & Supply ("GM3S") define the main requirements applicable for the implementation of service or supply scope of work [45].
The GM3S presents the main principles and requirements which the Contractor must take into account during the implementation of the scope of work and defines the minimum standards expected for the management of the Occupational health, safety ("OHS"), environment, nuclear safety, quality, contact control and all associated deliverables.
The Contractor **shall** comply with all the requirements of the latest instructed version of the GM3S and reference documents.

13.1 Work Monitoring

The Contractor shall ensure that access rights are granted to IO personnel at all locations where ITER work is being performed.

If the sanitary conditions allow it, two in-person meetings shall be scheduled at the IO premises: kick-off meeting, to be carried out in the first month after the contract signature; the closure meeting to be held after the approval of the last technical deliverable (item 8').

On top of the two in-persons meetings, progress meetings shall be foreseen regularly by video-conference. They will have to be indicated in the time schedule to be produced and maintained by the service supplier. Considering the duration of the contract, it could be considered suitable to schedule them every month. However, IO can request to carry out specific progress meetings in case of need.

Important: Minutes of the meetings shall be done by the contractor and sent to IO within 1 week maximum after the meeting day.

13.2 Acceptance Criteria (including rules and criteria)

The deliverables shall comply with all ITER requirements listed in this technical specification and shall be reviewed by the TRO and by experts appointed by the TRO (whenever necessary). Intermediate and final deliverables shall be properly prepared and approved by the Contractor. Reports and related documentation shall be stored in the ITER Organization's document management system, IDM by the Contractor for acceptance.

The ITER Organization shall have 30 days from receipt of reports to approve them. The ITER Organization reserves the right to request revisions. The IO shall submit reasonable grounds for such request. The Contractor shall have a maximum of 30 days in which to submit additional information or a revised report.

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13.3 Meeting Schedule

The meeting schedule shall be discussed and agreed at the Kick Off Meeting

14 Appendix 01

Drift Duct – WELDING CONCEPTION EXPERTISE		conception (drawing)						Table RS 7720 for Box and Branches and table RH 4500 for Supports								RC 3851 weld coefficient 'n' to be considered for calculation	skeches and pictures
		accessibility		type of joint	classification RCC.MR (level 2) box structure		Confinement weld	Before welding table RS7720-c1	During welding Table RS7720-c2		After welding table RS7720-c3						
Weld N°	View / Detail	during production	geometry thickness mm	type of joint	Category RC3833-3 or RB3633.3 on branches	Type Table RC3833-3a and RC3633.4 b on branches	yes/no	Examination of surface to be welded (surface examination)	Examination during weld operation (surface examination)		surface examination LP Method &		volumetric examination				
								extent	extent	backing	extent		Extent as requested by RCC-	method criteria			
								%	%	yes/no	%	on 1 or 2 faces	%	RT (radiography) RMC 3300 - RS7724-3 Possible on the requested volume?	UT (ultrasonic, only in case RT is not possible) RMC 2600 - RS7724-4 Possible on the requested volume?		

EXPRESSION OF INTEREST & PIN ACKNOWLEDGEMENT

To be returned by e-mail to: emilio.rondinella@iter.org copy virginie.michel@iter.org

TENDER No.	**IO/24/OT/10028089/ERA**
DESIGNATION of SERVICES:	**Absolute Valve Feasibility Study**
OFFICER IN CHARGE:	**Emilio Rondinella – Procurement Division ITER Organization**

☐ WE INTEND TO SUBMIT A TENDER

Signature: COMPANY STAMP

Contact person(s)

Name: ....

Position: ....

Tel: ....

E-mail...

Date: ....

Company information

Company Name…………………………………………

Company Address……………………………………

(*) Consortium member(s)……………………………

(*) Subcontractor(s)…………………………………

Website address……………………………………..

(*) if any